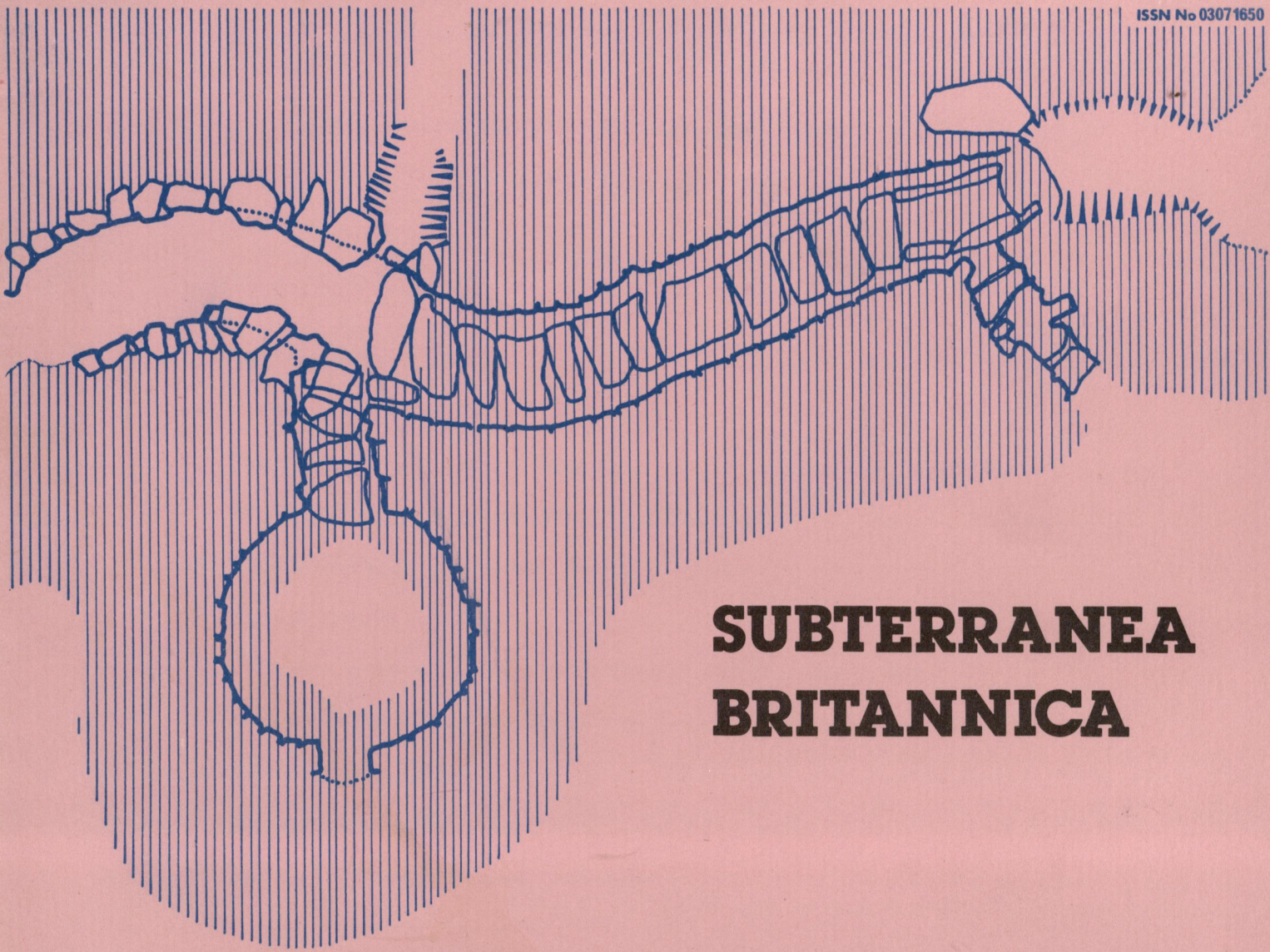
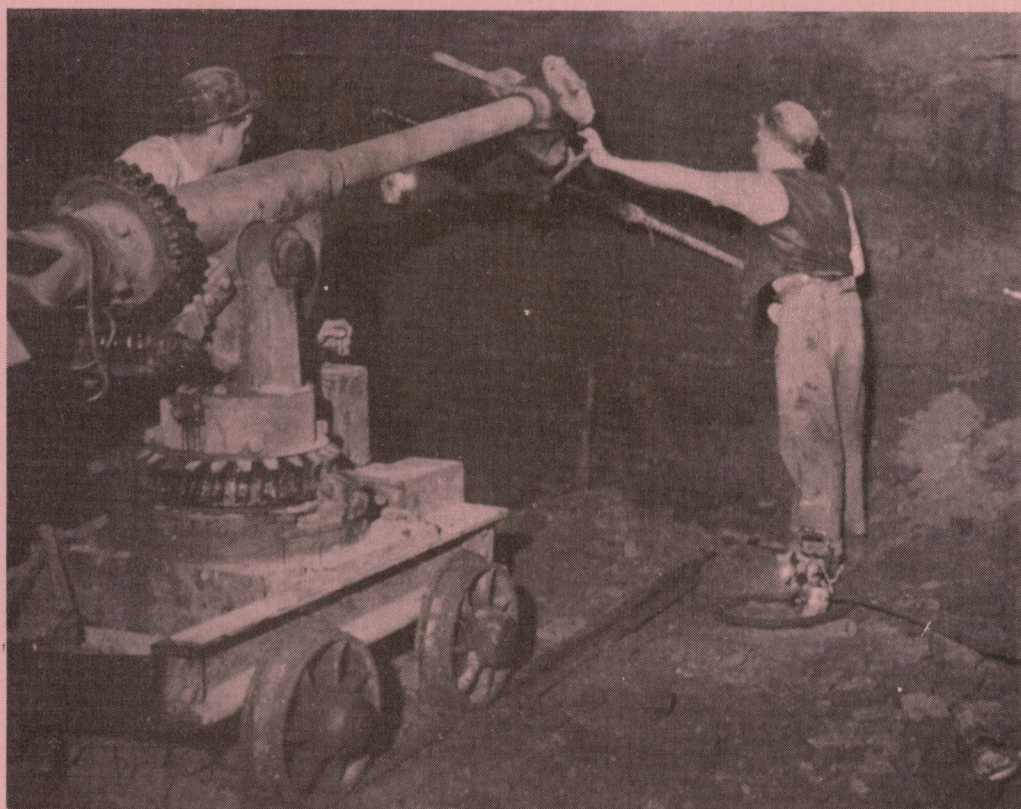




SUBTERRANEA BRITANNICA



Bulletin No. 26

THE BULLETIN OF SUBTERRANEA BRITANNICA

No. 26 - February 1990

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Subterranea Britannica is associated with Société Française d'Etude des Souterrains of France, Arbeitskreis für Erdstallforschung of Germany, and SOBERES of Belgium,

EDITORIAL

For some time now I have been concerned over the number of diseases to which archaeologists and cavers can be exposed. Some of you may have seen my article 'Archaeologists at Risk?' in Current Archaeology (No:95, p373,).

For example, Histoplasmosis infects people and bats by both the minute spore and sections of the mycellum known as Histoplasma Capsulatum. At present Europe is free from infection but it is endemic in many other parts of the world, in particular Central and Southern America, Central Africa and the Far East. The spore grows mainly in the droppings of bats and birds (the latter do not become infected, which is thought to be due to their higher blood temperature). Bats are an endangered species and European countries are trying to increase significantly their numbers. This will in turn increase the likely amount of guano. It is in the interests of all cavers and others NOT to introduce this infection into underground space.

Two years ago I formulated a questionnaire and my GP, who is also interested in the subject of Histoplasmosis, checked it over for me. I then had the questionnaire translated into Dutch and sent it to one or two cavers in the Netherlands who had contracted the disease when caving in Mexico.

On my GP's recommendation I further researched Histoplasmosis in the Cambridge University Medical Library at Addenbrookes Hospital. I was surprised to learn, for example, that in Australia the disease was unknown fifteen years ago, but is seen there now in some areas. This produced some questions. Was it endemic but not recognised before? If not, where did it come from? Was it a recent introduction? If so, how and by what means, or by whom had it arrived? I am now in correspondence with our Australian member, Phil Simpson, and have received several medical reports from him.

I think those of us who go into caves or even into man-made underground space should be aware of the dangers of carrying bacteria or spores of disease on our clothes and, in particular, on our boots. Two occasions have brought it even more to my attention last summer:

Some 70 of us, attending the Quarry Symposium near Paris, went into a quarry system where mushrooms had been grown. The beds, originally laid straight onto the quarry floor, still remained and we all walked amongst the old debris. A few hours later we visited a modern mushroom growing area in another quarry. If there was a mushroom disease present in the first quarry (we could not have known whether there was or not!) we could easily have introduced a problem to the latter grower.

The second occasion was that dead sheep had been dropped down to the bottom of a chalk mine shaft in Hertfordshire. Why had the sheep been disposed of in this manner in the first place? Did the farmer not want the authorities to know of the death of these sheep? If not, why not? Were they diseased? On my suggestion, those entering the mine on that visit have since disinfected their clothes and boots.

If any members have contracted Histoplasmosis would they apply for a questionnaire direct from myself. If you, or you know of anyone else who has definitely contracted an illness of any other description from caving exploits, would you or they also write in to me and explain the circumstances, please.

Sylvia P. Beamon.

This Bulletin is the official publication of Subterranea Britannica.

This Bulletin has been compiled and edited by Sylvia P. Beamon (2 Morton Street, Royston, Hertfordshire, SG8 7AZ) with assistance from Maureen Mahony and Bernard O'Connor.

With a few exceptions, most members of Subterranea Britannica are dealing with quite large areas of excavation whose existence is due to commercial exploitation of the rock. The Nottingham caves are very different because they are small discrete groups of cavities carved out of the Bunter Sandstone rocks as cellars and extensions to buildings above. Their use is in some instances demonstrably commercial but any financial gain from the sale of the sand is merely a useful spin off.

The monk, Asser, writing the life of King Alfred in the 10th century tells us that in the old British tongue Nottingham was called Tighuocubauc. (The spelling varies) This translates as 'the place, or the house, of caves.' When Asser said 'British' he was using a Welsh word for caves. The Kingdom of Elmet in Yorkshire, and possibly Notts, north of the Trent was 'British', i.e. Celtic or Welsh speaking until the 6th century A.D. Sad to say, no caves of this date have been discovered. However, let us imagine that pre-Saxon people exploited the southward facing scarp of sandstone overlooking the Trent. It is a soft rock and caves could easily be cut back into the rock face. This very softness is also a drawback which causes rapid erosion and these early caves would have been subject to collapse. At some unknown date it was discovered that if the rock opening was protected from the forces of nature, this problem ceased to arise. It is possible that by the time King Alfred arrived in Nottingham to sort out the Danes, the settlement on the hill, now crowned by St Mary's Parish church, had some lying beneath the houses and/or barns, though there is no evidence for any caves prior to 1250, archaeologically speaking. Alan MacCormick believes that most of our caves were dug after 1200 when military mining became an important and well understood practice. The surface archaeology in Nottingham is not easy, because the rock lies close to the surface and successive generations in preparing a plot of land for re-building, whilst levelling the ground in the time honoured manner, have done so by filling up any unwanted cavities in the rock with debris and then built over it. In this way many caves have been quite literally buried. By the time the area was developed during the Industrial Revolution into what we now call the Lace Market, many caves were damaged or destroyed to permit deep cellars, solid brick foundations, drains and so on, under buildings which were six or more storeys high.

During more recent times many caves were adapted for use as public air raid shelters. This policy had one very useful on-going effect, those caves and others were seen and remembered by the general public, who have over the years drawn attention to alterations and potential destruction. From this it is possible to pin-point over two hundred caves within the limits of the medieval town. Further destruction of caves occurred during the boom development period of the 1960/70s, with caves being filled with concrete as soon as they appeared. Reports of this sort of

activity came from the building workers and was always strenuously denied by those in charge, or if the cave could not be denied, the action was justified on the grounds that the structure above was at risk unless immediate action was taken.

It was against this background that Nottingham Historical and Archaeological Society came into being. An area called Broad Marsh was ear-marked for the development of a large shopping precinct. It embraced the site of one of only two medieval roads into the town from the south, a complex of caves that had been used as an air-raid shelter (and had been archeologically investigated in 1938/9 when they were interpreted as a tannery) as well as more recent post railway development of the early to mid 19th century.

So now a group of people came together to record and re-excavate the Drury Hill caves and campaign against the development which would destroy the caves and Drury Hill. It is sad to relate that the development was not halted, but the caves are now scheduled and hundreds of people are taken through them on conducted tours during the course of a year. The following information will deal with various cave systems, and briefly with what is known of their history.

The Drury Hill caves, now called the Broad Marsh caves since the disappearance of Drury Hill, are composed of three or four separate systems which were later linked by a passage. Let us begin with the two caves which would at one time have been open to the atmosphere, being cut into the cliff face just outside and beneath the town walls. Borough Records report of repeated complaints from the population of the stench which emanated out of the tanneries in this location. The tanners were also accused of polluting the River Leen, a tributary of the Trent, now culverted, but which would then have been flowing nearby.

The Pillar Cave was of particular interest. It was obvious that what could be seen was an incomplete cave chamber where the outer half of the cave roof had collapsed. The cave was then apparently abandoned for about one hundred years. When the passage was cut through, with its floor at a higher level, the sand was used to back-fill the remaining floor area covering a series of tubs which are now known to have been used to de-hair skins in preparation for tanning. The whole was then covered by a plaster floor; - the dating is loose, but put at the Tudor period - or perhaps a little later; we had already pushed back the dating of this complex by two hundred years. As clearing the accumulated debris continued a dogs' grave lined with stones was found. Under one of those stones was found a half groat of Henry IV (1399-1413) and finally, dug into the rock floor of the cave, a cess pit which yielded pottery dateable to the late 13th century. The planners could no longer ignore the historical importance of the complex.

The adjoining cave had been emptied before the war but was once again full of rubbish and when cleared was found to have a series of rectangular pits cut into the floor, undoubtedly the tannery referred to in Mr Campion's unpublished notes. Another area, which it was not possible to save in its entirety, had been a butcher's store-room, with direct access to Drury Hill up a flight of rock cut steps. Here were found some nice examples of 18th century pottery. The third system had been completely back-filled and bricked off. When cleared it revealed a brick floor and benches with some salt glaze pottery which helped the group to trace Samuel Hancock's un-signed ale house at the foot of Drury Hill, referred to in the Borough Records on three separate occasions during the early to middle 18th century. These caves are owned by the City of Nottingham and are incorporated into the Museum Service. The guides for the tours are volunteers who belong to the Friends of the Nottingham Museums.

One thing not mentioned before is that whilst working on Drury Hill, the Society was not allowed to take rubbish out of the caves. The developers had said they had enough on their hands already. The Corporation maintained there was no money available to pay for skips. A great pity, because at that time it would have been very easy to get it out. When the development was complete there was only one possible exit for the rubbish and it was then no easy task for the A.T.C. cadets who finally removed our spoil heaps.

Bridlesmith Gate was a block of property which had been purchased by a private company. It was somewhat dilapidated because the area had been ear-marked for demolition to allow

for road widening. This scheme was scrapped and now here was someone who was going to restore the early 18th century structures and who wanted the caves beneath cleared and made available to visitors.

Here at Bridlesmith Gate we were being told that all rubbish should be removed and that a skip would be provided at all times, our joy was inexpressible!

There is no doubt that these caves were built as cellars. Any brickwork is obviously a later intrusion into pre-existing chambers and the earlier buildings could only have been timber framed. In this case, the cellar was still required and was adapted to suit its new owners. An earlier door is bricked off and a thrall built across it and a new entrance created into the far cave which had brick wine storage bins erected in it. Before that could be done a large pit was back-filled to level up the floor. To excavate the pit several bins which straddled it had to be demolished, but two were left and are now used to display some of the finds. Another system accessible from the same 18th century cellar produced the first known ice-house within the city boundaries. It was two years later that a similar one was re-discovered during rubbish clearance under the Castle, which at one time was the Duke of Newcastle's residence. There is a debatable historical link between the two, as the Duke's confectioner who used the Castle ice-house is known to have had premises on Bridlesmith Gate and the writer for one, likes to think we have discovered the site.

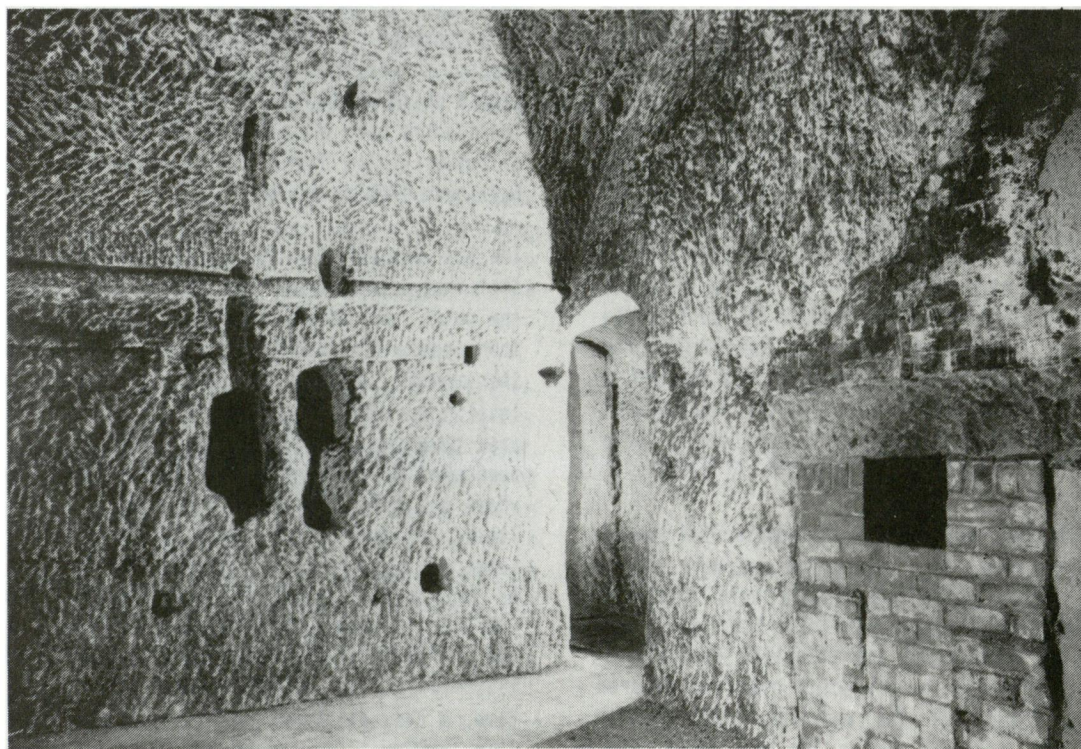


Plate 1 - Hermitage Caves: Castle Boulevard, Nottingham

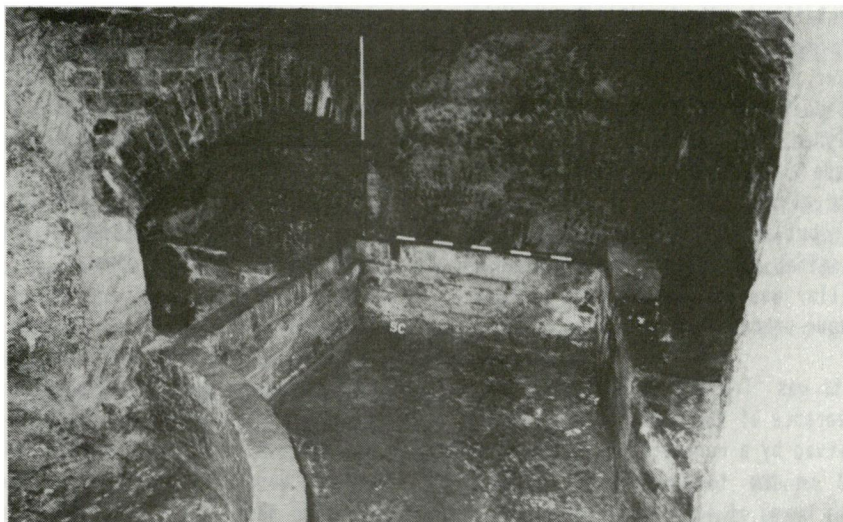


Plate 2 - Storage bins: Middle Pavement, Nottingham

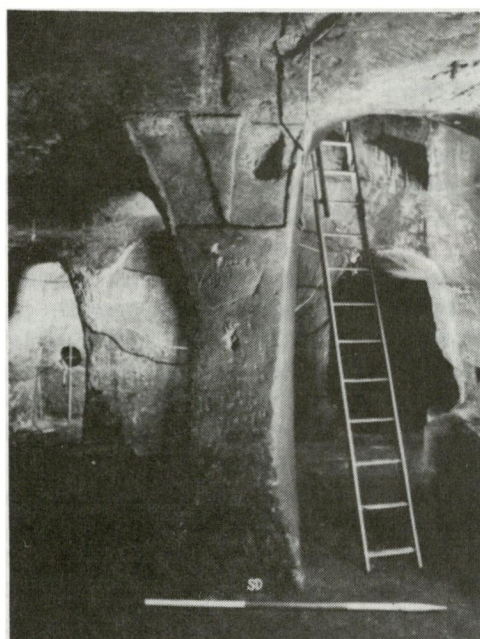


Plate 3 -
Carved Pillar:
Middle Pavement, Nottingham



Plate 4 - 'Chapel' Cave: Bridlesmith Gate, Nottingham

Up to this point we had discovered no rock carving or graffiti apart from a mysterious 'S' in the Drury Hill passage. Our next cave revealed a beautiful short armed cross in low relief cut over a doorway. The cave was under and behind a timber framed building that was in such a bad state it had to be demolished. Here we found a series of pits and out of one of these a thirteenth century cooking pot was found. The near end of the cave had been destroyed by a brick foundation wall, but access had been made from a higher level down a brick spiral staircase. What had been a very attractive central pillar was damaged by 19th century adaptation of the cave to some unknown use.

Our next example of graffiti was 'Trollkelle' which made no sense and the Teutonic appearance of the letters led many to believe that it had been carved by a Hanoverian soldier, one of a troop once quartered in the town, and that he was indicating the location of a house of ill repute. The writer was not privy to the discussions which arrived at this conclusion. The truth is very different. This is a medieval hand, the 'lk' of Trollkelle should be read as a 'w'. This gives us 'Trowelle', the name of a village to the west of Nottingham. In the 16th century Sir Richard de Trowell was priest at St. Peter's Church and this cave was situated only a few yards from the church. We had, perhaps, found the location of the priest's house through the remains of a ruined cave. Even that has now gone under a modern development.

In the late 1970s members of the society moved onto a plot of land whose building had been demolished many years earlier and was waiting development. Caves had been seen whilst the building still stood and we went looking for them. Here were found several large caves linked together, two wells and two malt kilns. The remains of a brewery, in fact. These caves have been scheduled and it is hoped they will be available to visitors when the current re-building has been completed. Over one of the doorways an incised cross was noted, a feature which has been observed in other caves and seems to be placed so as to face anyone entering the caves. The brick stairway from which it was approached during excavation was added at a later date thus destroying the original entrance. The malt kiln has been badly damaged, but undisturbed beneath a brick intrusion. 15th century pottery sherds were found in the ashes of the last firing. After it was abandoned, the kiln was backfilled and bricked over with early bricks, then later the top half of one quadrant was dug out to allow a cistern to be inserted. Both wells in this system were accessible from both ground level and from within the caves. In this part of town the water table is approx. 8.50m below cave floor level.

The Peel Street Caves are the exception to the domestic structures. This is a large area excavated on an irregular pillar and stall system, with galleries at two levels, the intervening rock was later removed and imparts a figure of eight appearance to the wall profile. This was exploitation of the sand under the common fields on the outskirts of the

town, which could only be extracted by mining. There is no truth in the antiquarian theory that Troglodytes perched on the ledges of this underground fortress to hurl stones at their enemies when attacked! What is true is that the place was strung up with fairy lights and our Victorian forebears would part with 6d (old money) for the pleasure of strolling about and being entertained with music in this underground grotto. During W.W.II it was an air raid shelter and more recently it has been used as film locations and also for training Drug Sniffer dogs.

These cellars with their constant temperature of 55 degrees Fahrenheit, together with the pure water filtered through the sandstone gave Nottingham an early and well deserved reputation for good ale. Many of the modern pubs still use the original cellars, with the addition of cooling systems and our most recent excavation beneath a city centre pub has revealed additional caves which had been used by a butcher. The Brewery's deeds for this property go back to 1668. Local archives have revealed that this property and the one adjoining were occupied as a public house and a butcher's shop right up to 1919 when the butcher's shop disappeared.

More recently the Society has been engaged in removing debris from a group of caves which must at one time have been two or more separate systems. Documentary research is about to commence, but it is known that part of the system was an air raid shelter and before that it was used by a butcher. Another section, badly damaged by Victorian and more recent brick foundations, has all the earmarks of a mediaeval cave complex. The debris can be dated by pottery and builders' rubbish to late 19th/mid 20th century origins. The afore mentioned details are no more than a very brief glimpse of the total picture. We continue to investigate any systems reported to us. When possible (and time is the limiting factor,) a detailed survey is made. Things have been rather quiet over the last few years, but with the brightening economic outlook re-development is once more taking place and this is when we expect to learn of forgotten or previously inaccessible cave systems.

The author has tried to convey the fascination of our small spaces, with their continual adaptation to new uses over the centuries.

(See also Subterranea Britannica Bulletins 2,9-10; 4,2-3; 8,10-11; 9,10-16; 10,14-16; Subterranea Britannica Proceedings of the Joint Symposium with SFES 1978, 14-15 & 43-50.)

DISCOVERY OF SO-CALLED ANHISTORIC HYPOGEA

These cavities were officially discovered in the summer of 1957, when the space existing beneath the 'Fossar Xic', a small old square close to the walls of the Basilica of Santa Maria de Mataro, was found by the local archaeologist, Mr Maria Ribas. Such structures were called 'fresqueres' or 'grutes' (which simply means 'a cave') by some of the older members of the village. Since then many of them have been the subject of study and were thought to have been hewn during the Roman period.

RESEARCH ON HYPOGEA

Owing to lack of information, the subject was abandoned by Mr. Ribas, and nobody wanted to follow up this area of research since it was considered to have no artistic or archaeological interest. Many years later Dr. Maurice Broëns, a French investigator, came to Mataro to see the hypogeum at the 'Fossar Xic'. Thus started a new era of research, positive and heterodox, trying to find a relationship between such cavities with others existing in France and Central Europe. He qualified these cavities with the adjective 'anhistoric', since there was no evidence to place these structures in a particular historical period. During the 1970's Joaquim Aguilar, a young investigator, followed the research started by Dr. Broëns and lots of new cavities were found in Catalonia.

PUBLISHED WORK

There are just a few publications on Catalan hypogea. Some descriptions of them were published in the specialised magazine Chthonia, a Spanish-French publication edited by Herder, no longer in print. Alternative information on hypogea can be found in some books by Mr. Ribas and some of it is reiterated in other booklets dealing with the general archaeology of Mataro. The French Subterranea has devoted some articles to this subject etc. (i.e. Symposium de Cordes). There is also a rare book, fully illustrated, issued in Austria or Germany about 1900, that deals with hypogea in Central Europe

SHAPE OF HYPOGEA

The typical Catalan hypogea or 'gruta', consists of a narrow corridor, hewn in the clay or in granitic soil ('saulo' in Catalan), forming one to four or even more corners or bends along its length. Usually a round or square cell exists at the end, and in some cases two or more cells can be found. A bench or 'podium' is also usually hewn around the cells and 'forniculae' (arched niches) often appear in the walls.

Their average length covers from 10 to 30 metres, that is obviously very exaggerated in comparison with the scanty dimensions of the cells the corridor leads to.

The average height is man-sized and usually from 0.70m to 0.80m in width.

SITUATION

At first investigators thought that such hypogea were exclusively urban, however later work has shown that similar cavities also exist in country areas.

The entrance to the hypogeum is in most cases intramural, that is inside the walls of a house, and often remaining concealed. This sometimes leads to difficulty in access for investigators.

They often appear to be in close relationship with the dwelling, and this fact suggests that they did not have a collective use, but were exclusive to the family unit. They seem to be cut with the intention of the whole being kept inside the estate perimeter.

ORIENTATION

In all cases the hypogeum develops in such a way that its cell could be placed beneath an orchard, yard, court, street, cemetery or clear space, i.e. not below a dwelling. However if a church or hermitage exists in the surroundings, it leads towards it, and often the cell is hewn close by the walls of the shrine.

At first it seemed the cells were orientated eastward or to the south-east, that is to say that a person sitting at the end of the cell or chamber would look towards these directions. Later it was demonstrated that the orientation is not consistent at all, since they obey a more compulsive rule; to head, where possible, to the foundations of a church or any kind of shrine, or even just to find an open sky site.

AGE OF CONSTRUCTION

They cannot be dated precisely. In many cases they appear to be closely connected with dwellings dating from the 15th, 16th and 17th centuries, as per documented sources. If the house was built during different periods, the hypogeum is found in the oldest part of the house, dating from late medieval times or more often from the 16th century.

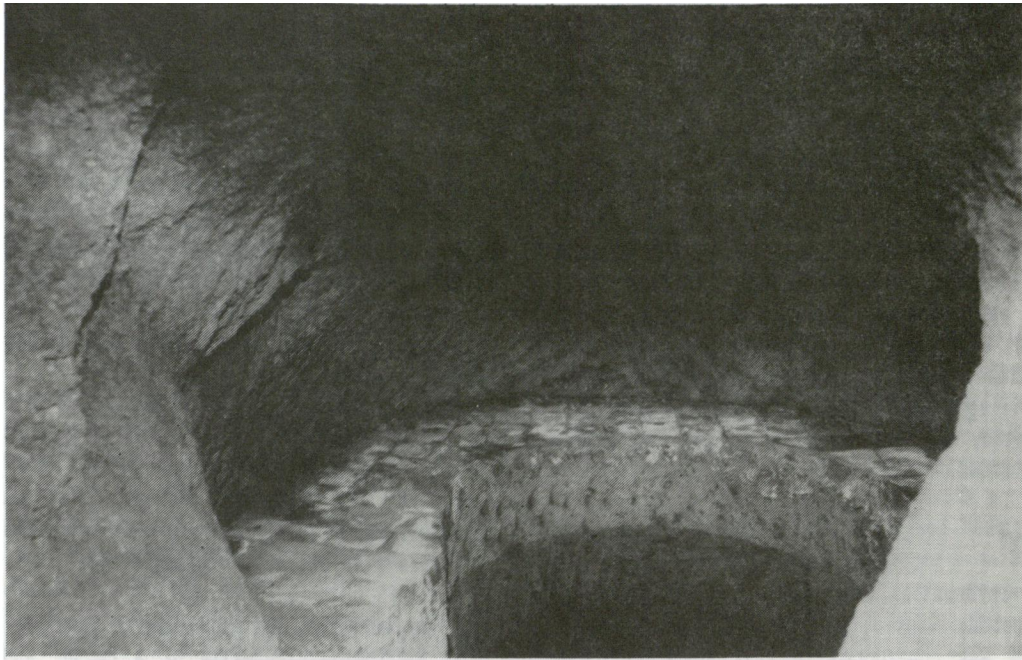


Plate 2

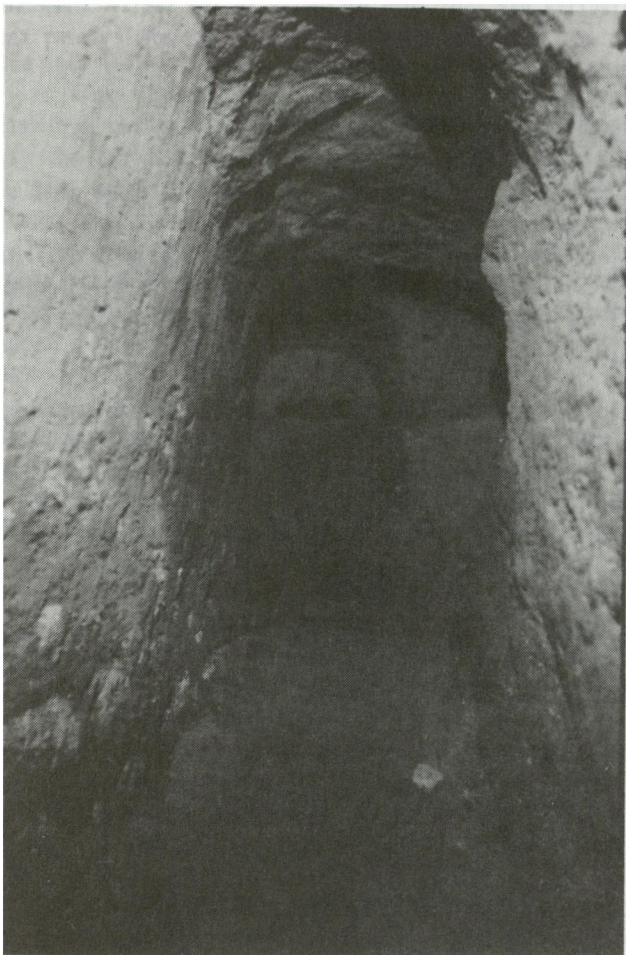


Plate 1

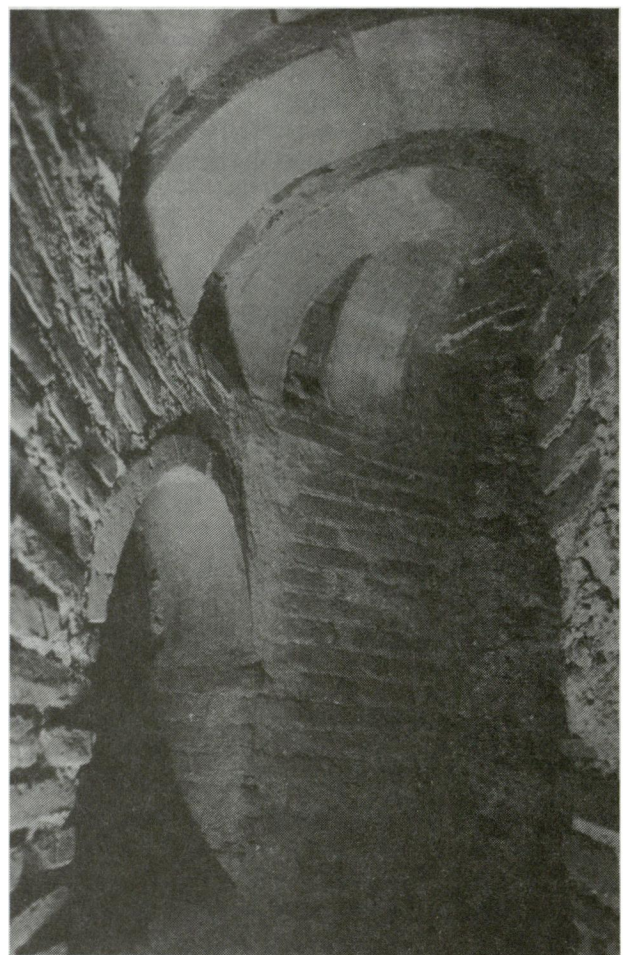


Plate 3

From the ceramic remains, such as cups, plates, pottery, etc., that have been thrown away into the cavities, with broken bricks and building materials from different ages, the time of construction could be fixed between a wide period covering from the middle ages to the 18th century.

About the 18th and 19th centuries these hypogea were walled up or filled in with stones and bricks to obstruct the entrance. This fact might lead one to think that maybe their mission was finished. Anyway, some of them were still used as 'fresqueres' (cool storage), owing to their obvious suitability for use as a 'fridge'.

FINDINGS AND RELATIONSHIP WITH OTHER REMAINS

Unfortunately, apart from the rubbish, no remains of interest have been found in the Catalan hypogea. In a few cases burnt bones of birds have been left inside the niches, and also some pieces of iron bars or hooks, possibly dating from the times they were used for food storage.

Some 'graffiti' also exist in some hypogea, many of them featuring cross shapes. In my opinion this fact opens a new area of research owing to connections with other kinds of archaeological monuments, such as standing stones, etc.

The most striking features in Catalonia were the discovery of a raw (*sic*) capital and a horsehead carved on the wall, the latter found in Vilanova i La Geltru, not far from Barcelona. However, both features must be considered as unusual examples. Note that other horse remains are connected with other such mysterious cavities, even in England, as per Nigel Pennick's works.

In many cases, Catalan hypogea are referred to by many as being apparently sites of ancient origin and are thought of as 'sitges' (that is, silos or storage pits) or even anthropomorphic tombs.

GEOGRAPHICAL DISTRIBUTION

This subject is already in hand. Till now the most important concentration of hypogea has been focused on Mataró, scattering towards Barcelona and the 'comarca' of the Maresme. Some of them exist in other areas, mainly in the Valles Oriental, Terrassa and Valles Occidental, Garraf and Penedes. That is more or less the Catalan coastline. More recently other 'grutas' have been found inland, in the Segre 'comarcas', Cerdanya, etc., and, undoubtedly, others are still unknown.

It seems that this distribution does not refer to ethnical causes nor to political and/or social history, nor even to climate or geological configuration.

SOCIAL ASPECTS

There is no formal linguistic designation to the word 'hypogea'. The word 'gruta' refers to such features in old notarial records. However, a kind of 'taboo' seems to be involved. The writer is reminded of 'pagan' rites that have come down to the present through folklore and tradition. Perhaps an echo of Roman family spirits - lares and manes - or even those of the Celts may be connected with 'hypogea', as suggested by the French writer Restif de la Bretonne, in some of his works.

PROPERTIES OF HYPOGEA

Apart from the unchanging temperature nothing is known about them. The idea is also proposed that they have been used as shrines or for worship or as curative places.

Thus the subject could be another area of research for those interested in Earth forces. Interestingly, the early research in this field was carried out by the Jesuits in 1905 in the Observatori del Ebre, near Tortosa. However they had to remove all fittings, galvanometers and wires because of the new electric railway in the surroundings which prevented them continuing their work here and it was transferred to the Jesuit College at Stonyhurst near Bolton, Lancashire.

Henri Puig-Geralt is still researching the subject. He appreciates there are several leads still to be followed up, from the distribution in the country at large, down to the omission of the orientation in most of the individual hypogea plans cited in this article.

Plate 1. Subterranean structure at the Fossar Xic
(corridor and 'forniculae' with carved cross)

Plate 2. Subterranean structure at Can Palau-Boyer, Mataró,
(the great chamber with 'podium')

Plate 3. Subterranean structure at Can Baró, Mataró,
(details of bricks and vaults)

CATALAN HYPOGEA

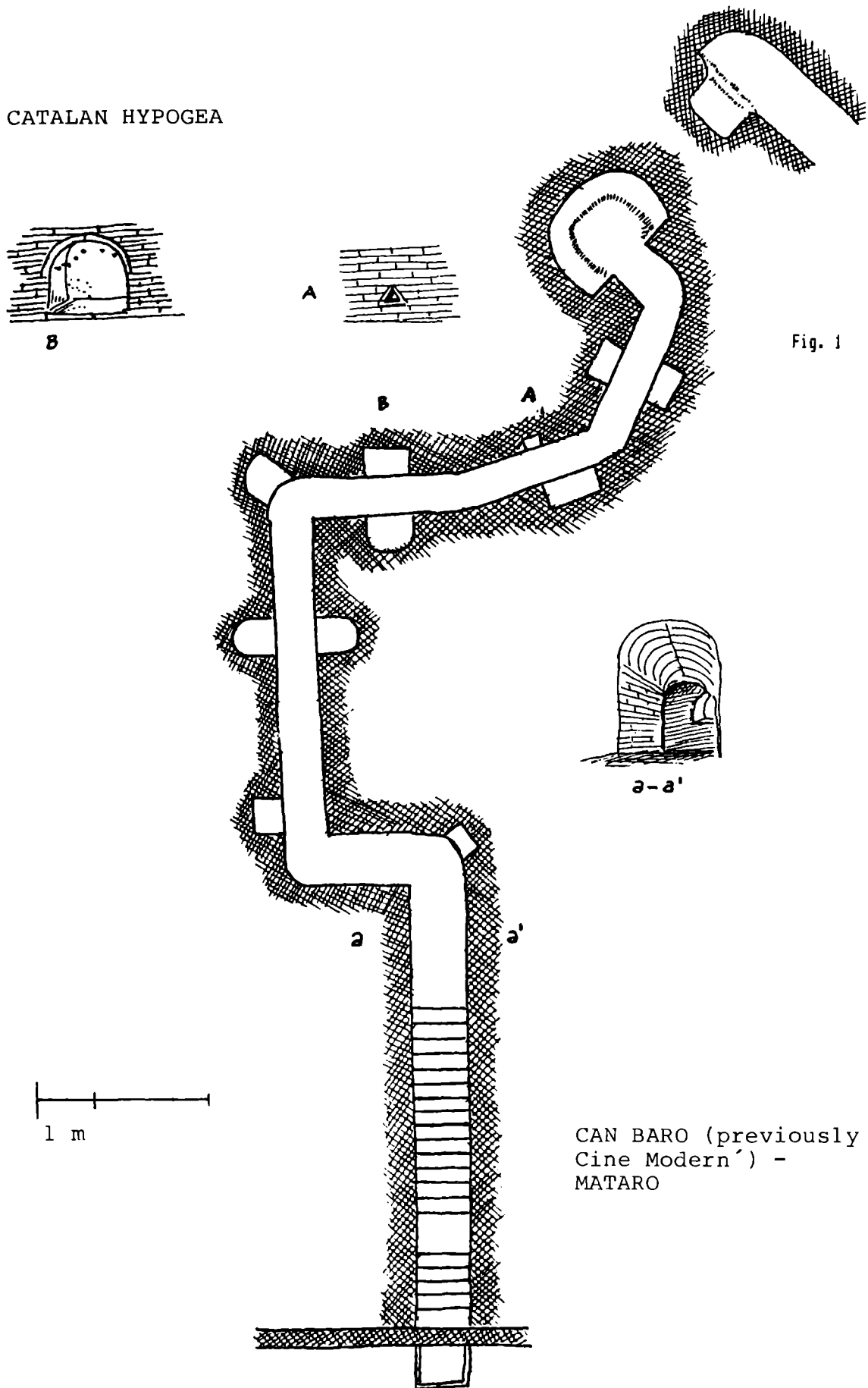
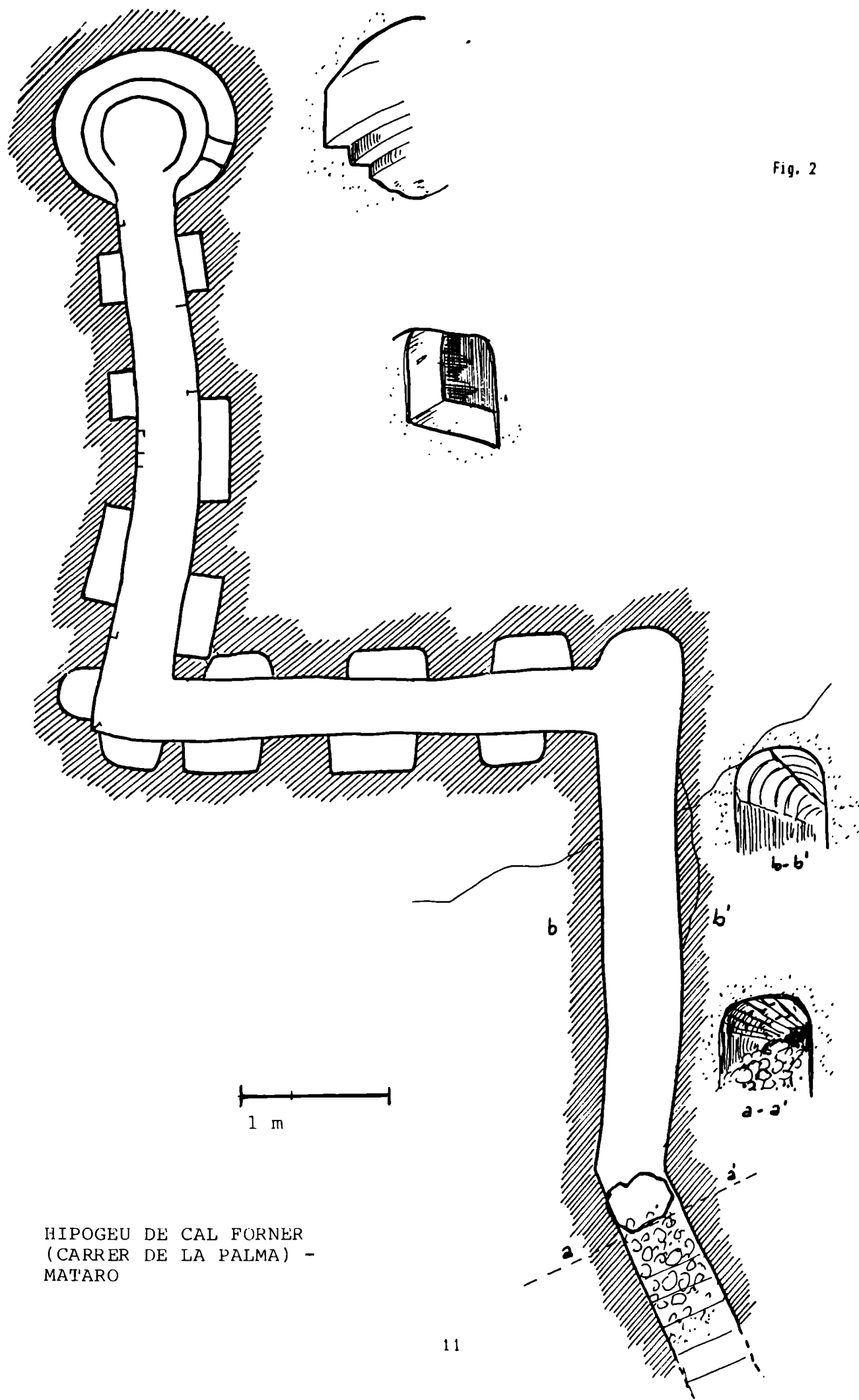


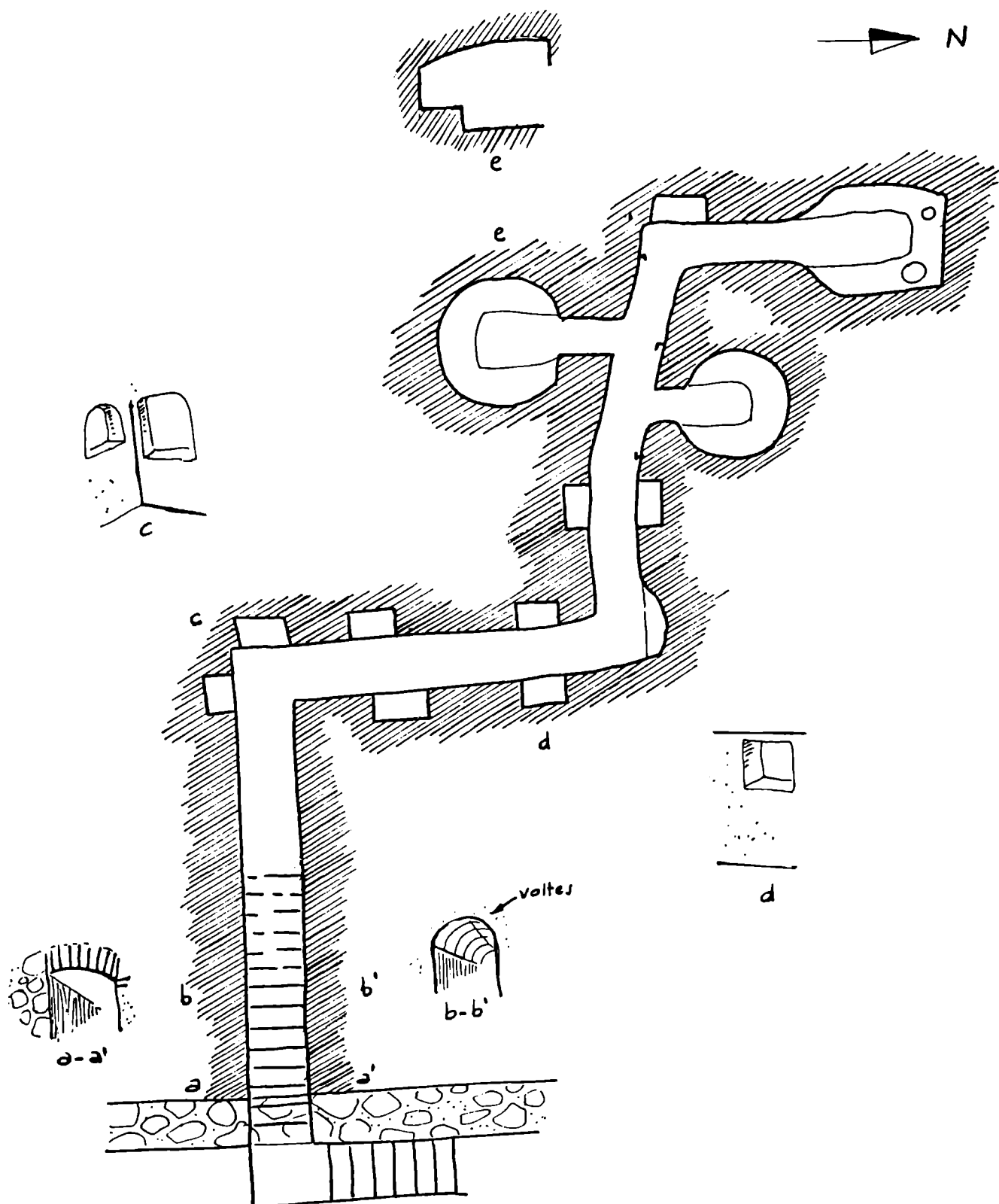
Fig. 2



HIPOGEU DE CAL FORNER
(CARRER DE LA PALMA) -
MATARO

GRUTA DE LA
RECTORIA DE
CABRERA DE MAR

Fig. 3



Enric Pulk i Giménez

1985

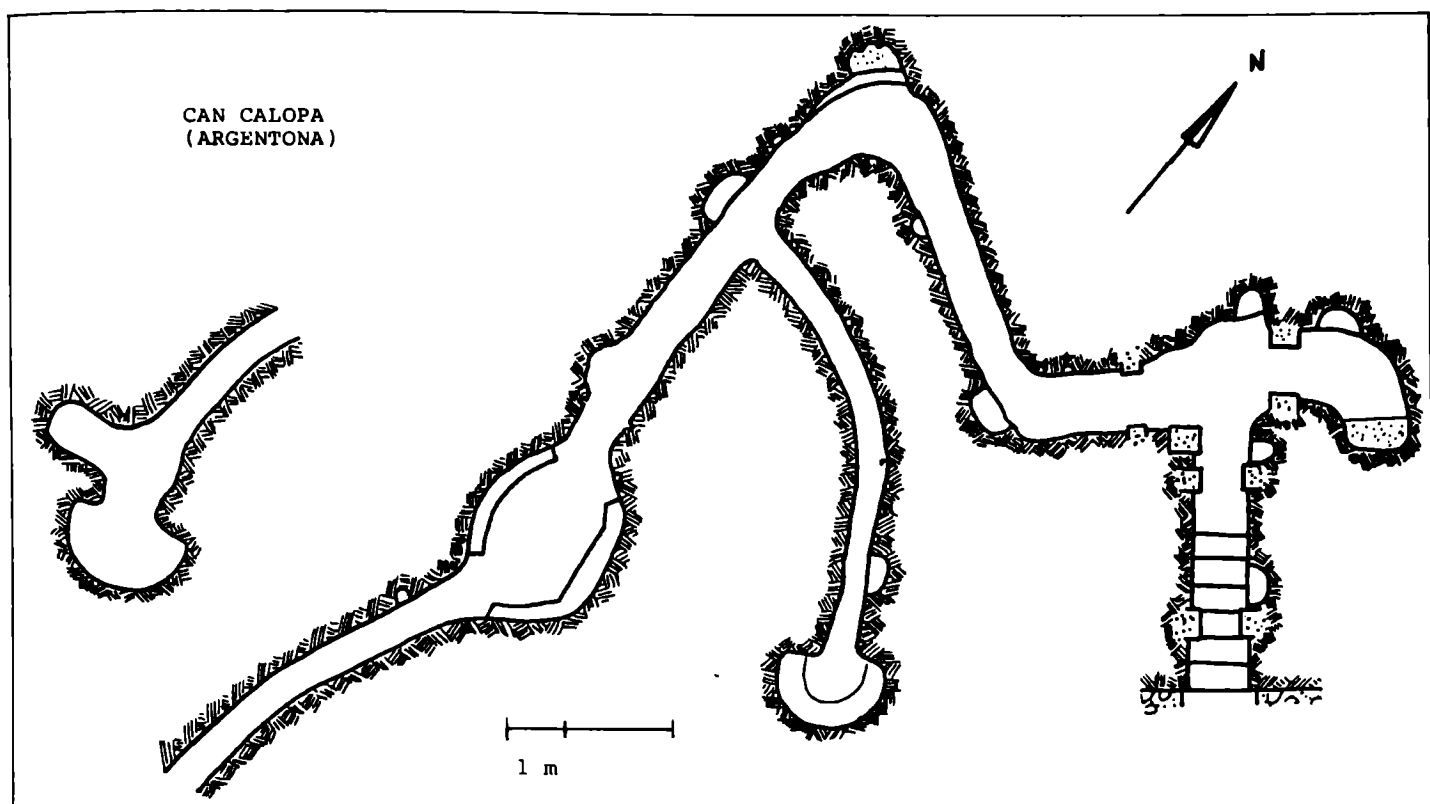


Fig. 4

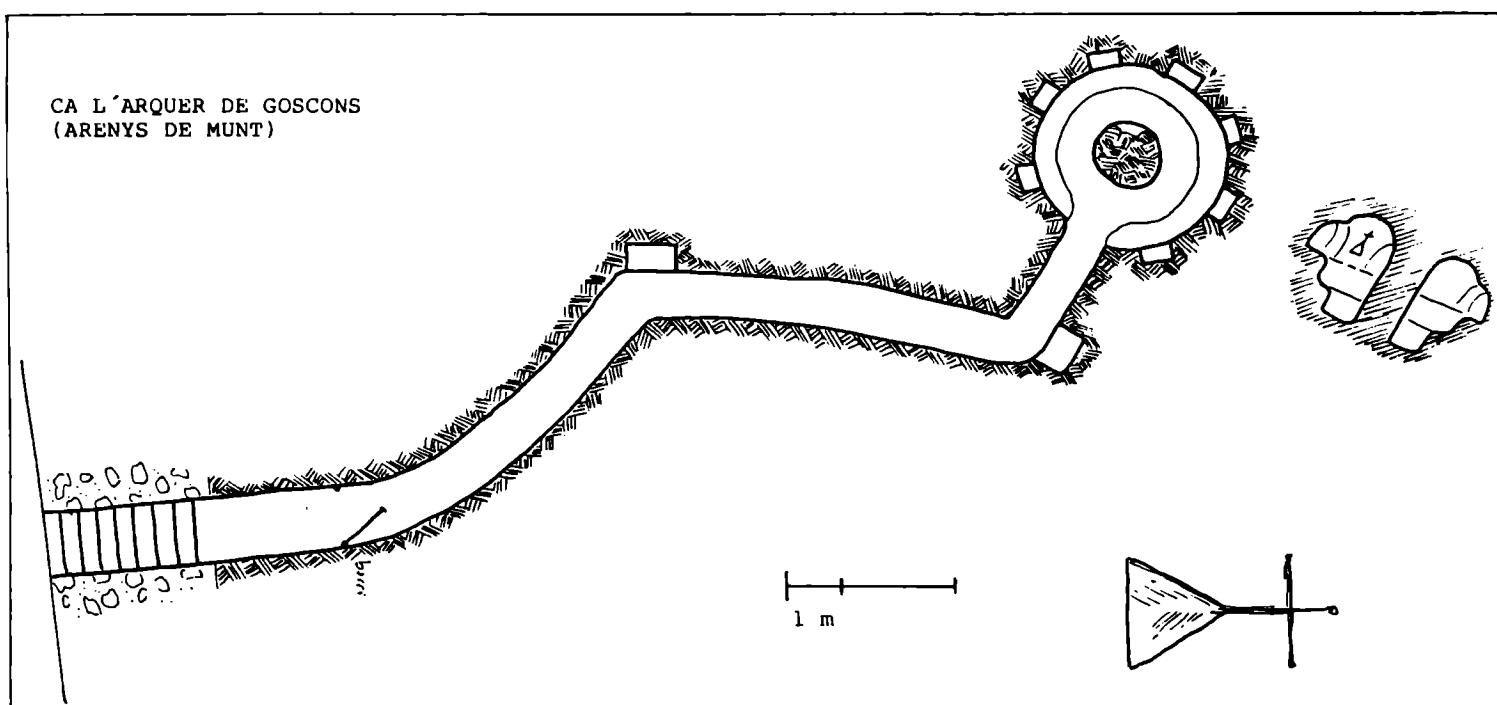


Fig. 5

THE VARIOUS USES OF A CAVE ON SKYE.

Paul Yoxon B.Sc. F.G.S. of the Isle of Skye Field Centre

Location Rudh'an Dunain, Glenbrittle peninsula

Grid Ref. 399/162

The isolated peninsula of Rudh'an Dunain houses a wealth of archaeological remains from a Neolithic chambered tomb to the more recent remains of the dwellings of the MacAskills of the Rubh who emigrated to Carolina during the Clearances of the nineteenth century.

Situated on this peninsula is a cave measuring about 4m deep by 5m wide, cut deep by nature into the basalt crags. This was excavated 46 years ago by Mr W Lindsay Scott, who revealed evidence of the cave's various uses spanning over 2000 years of history.

It was first used as a stone knappers workshop and many artifacts dating from this age were found, including ornate bloodstone scrapers and the remains of pottery fragments including a beaker. The use of the bloodstone is most interesting since the only locality where it can be found in this area is on the adjacent island of Rhum. The bloodstone itself is a very hard silica based substance, and this find on Skye indicates some sort of connection or possibly trade

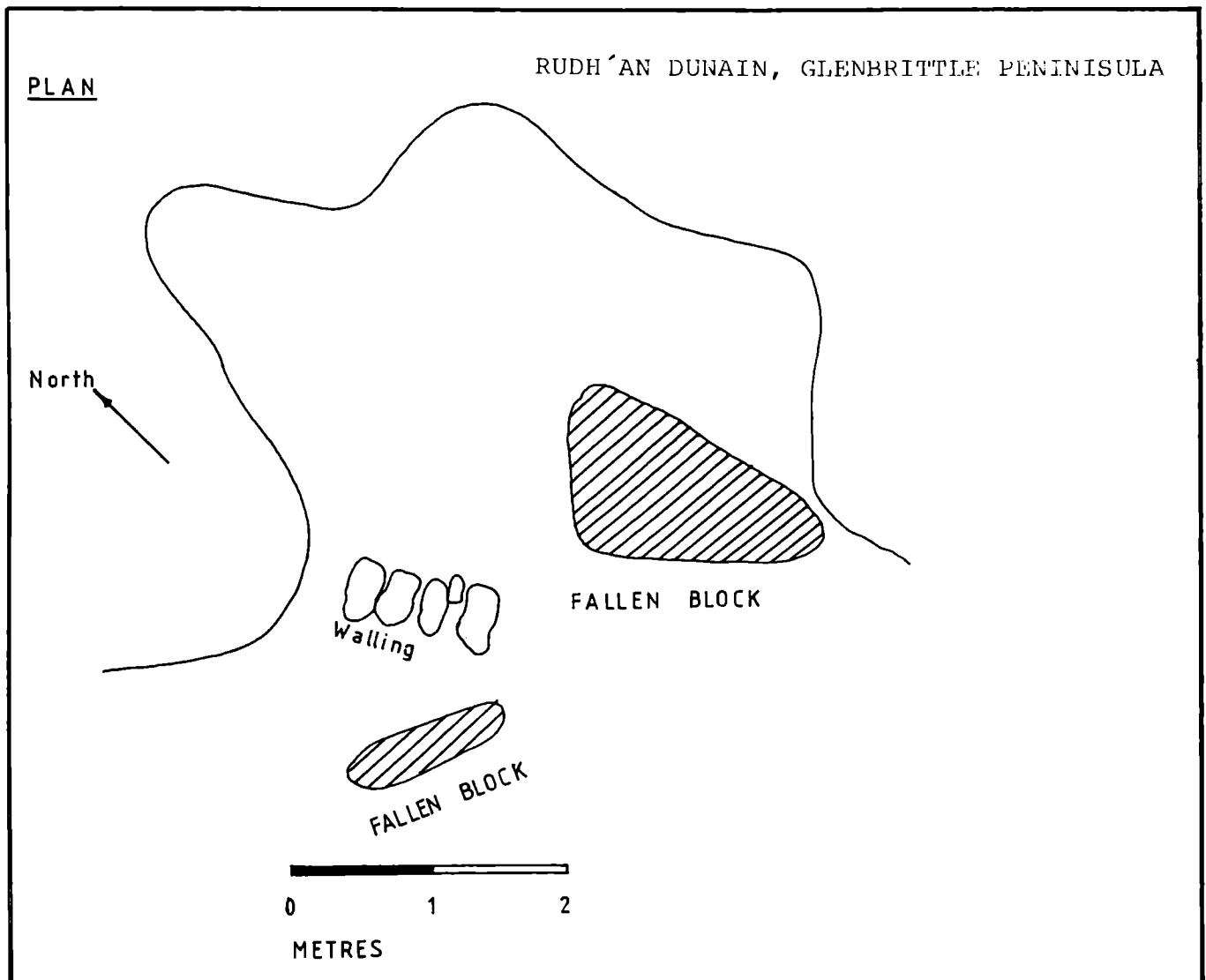
with their neighbouring islands.

In the early Iron age the cave revealed evidence of a smelting furnace and it is still possible to see evidence of this iron slag today.

More recently, in the eighteenth and nineteenth centuries, the cave was used for shelter for shepherds. From this period there is clear evidence from the finding of iron nails and fragments of iron pots, together with a slight attempt to wall part of the inside of the area.

The cave however has never been a permanent residence, But hut circles at the base slope away from the cave and indicate a settlement area from which successive generations would have utilised the cave for various reasons.

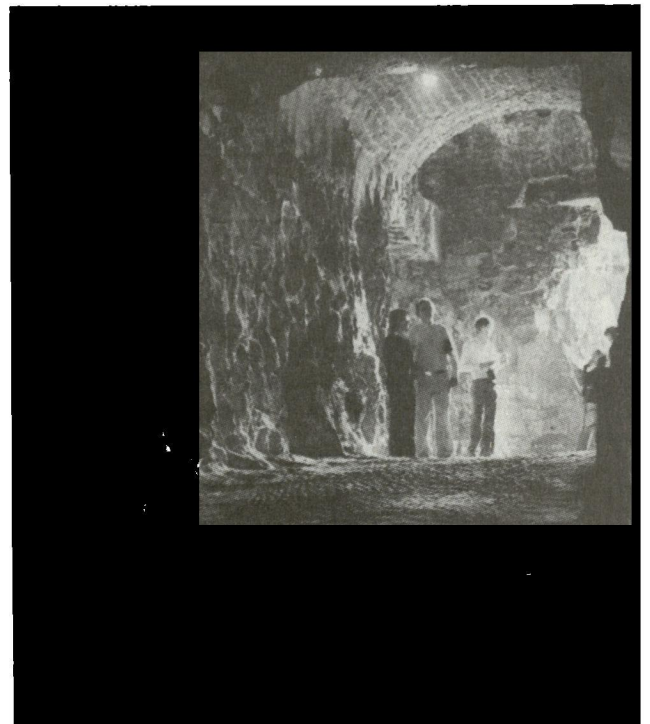
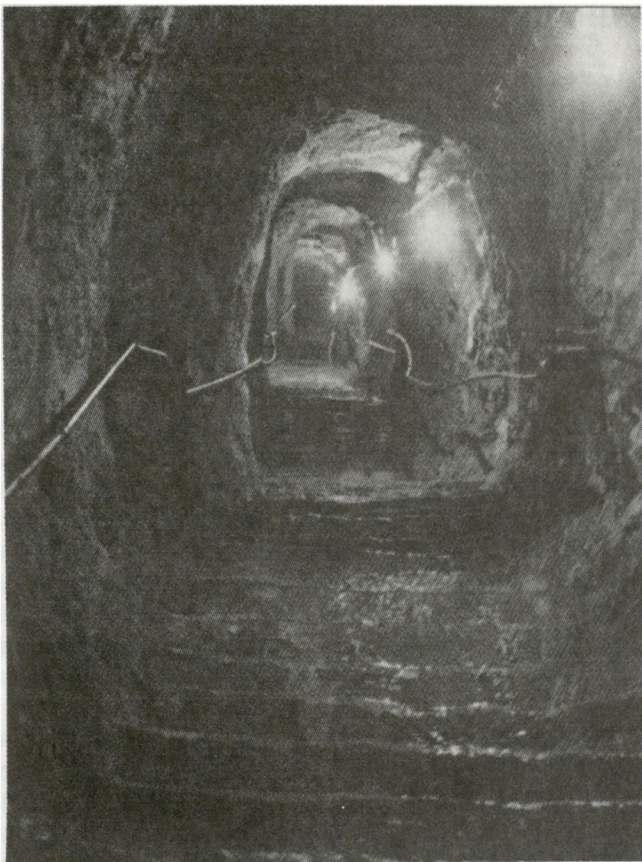
Ref. Proc. Soc. Antiq. Scot. 1931-32, Vol. lxvi



THE BOCK CASEMATES OF LUXEMBOURG

In 963 AD, on Bock-cliff, Count Sigefroi built his castle. It was to be the foundation of Luxembourg. By and by this small town increased in size and tremendous circular walls were built for its defence. But in spite of all these measures the Burgundians took possession of it in 1443 and after that, Luxembourg passed through many foreign hands during the next four centuries. The best fortress engineers of the dominators (Burgundians, Spaniards, French, Austrians and German Confederation) worked on the fortifications and Luxembourg became one of the most important fortresses of Europe, the 'Gibraltar of the North'. For its defence 3 fortified girdles were built with 24 forts, 16 other large defence works and a huge underground network of 17 miles (23 km) of Casemates, to shelter many thousands of soldiers as well as horses, workshops, kitchens, bakeries, slaughter-houses etc.

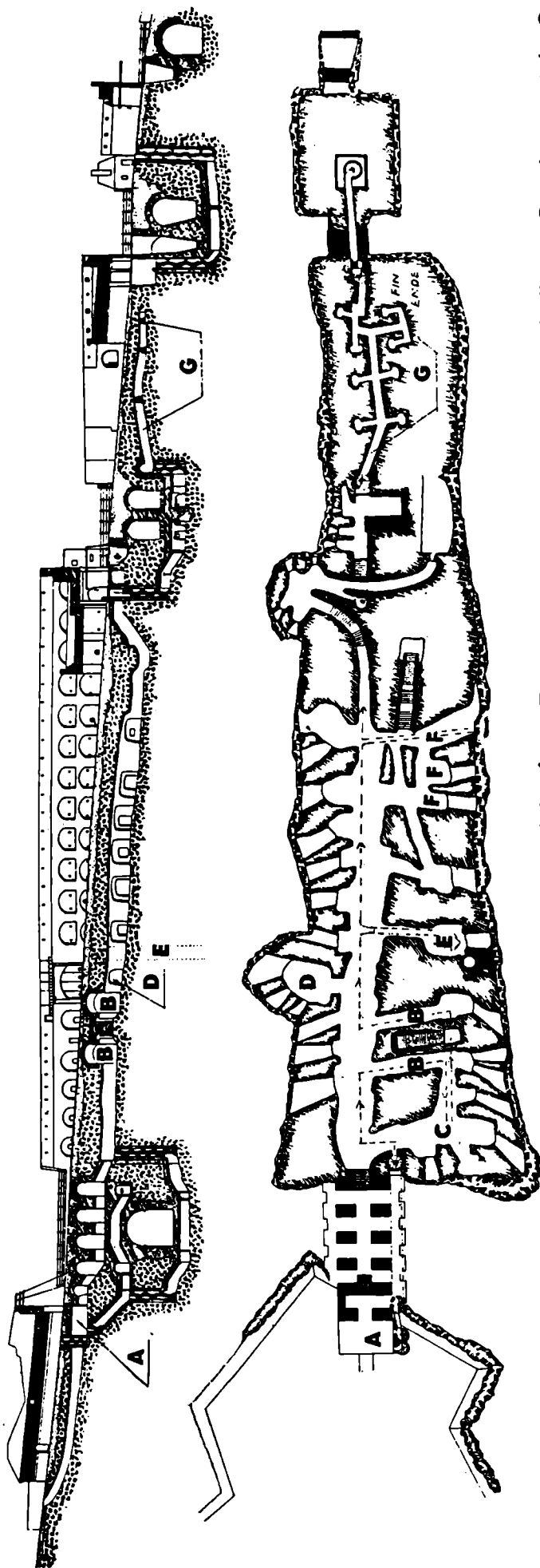
In 1867 the fortress had to be evacuated and dismantled due to the fact that Luxembourg became neutral. During the time of the dismantling (it took 16 years) most of the fortifications were blown up, the superstructures of the Bock included. But it was impossible to destroy the Casemates without destroying part of the city and nowadays some of them are turned into private cellars. The main connections and entrances were closed but 11 miles (17 km) remain; some of them have several floors connected by huge staircases descending more than 120 feet (40m). Needless to say, during the World Wars the Casemates were used as bomb shelters; there was room for 35,000 people. In 1963 important remains of the old castle were discovered and converted into the monument of the Millenium of the City.



UNDERGROUND FORTIFICATIONS: BOCK CASEMATES OF LUXEMBOURG



Visit of the «Bock-Casemates» and bridges, established by the Austrians between 1737 and 1746.



Model of the Fortress exposed in the «Rathskeller – Cercle», rue du Cûre

A, Winding stairs lead into a passage which was prepared in case the bridge got destroyed. After passing underneath the road and ascending again by another winding stair, it opens into the main gallery with its cannon-rooms and loopholes. Here 50 cannon were ranged. The garrison of the Bock Casemates was about 1200 men. The loopholes were enlarged when the fortress was dismantled.

B, A right turn leads into the cellars of the keep of the ancient castle. Through the now closed openings in the upper ceiling, cannon used to be brought down so as to avoid staircases.

C, Entrance is through the iron door to the Ground Battery which had loopholes for 8 cannon; they were fired by turns (3 times an hour) to defend the suburb ground, the ramparts and the Citadel.

D, The tower of the former castle. On the other side of the valley remains of a fort of the outer girdle. To the right, on top of the Bock Cliff stands the Hollow Tooth.

E, The well of the former castle is 150 feet deep. (46m)

F, Former head-quarters of the 82 year-old Field-Marshal von Bender during the siege of 1794-95. (Bedroom, office, antechamber). Wonderful view through the loophole onto the inaccessible rocks, Spanish ramparts (1632), the city, the suburb ground, the ancient abbey of Munster (1620-1691) reflecting its church in the water of the Alzette River, the Rham Plateau with ancient barracks built under Vauban (1685) and several old towers, remains of the third city wall (1390), the viaduct (1859). Other staircases lead down underneath the Hollow Tooth (loopholes) and, by further

winding stairs, one passes underneath a second bridge of the Bock. The loopholes on the left used to protect the walls and the moat which were built under Vauban between the Bock and the Alzette River. On the right is a room to quarter the guards.

G, Mine holes to blow part of the Bock.

The Society is indebted to the Liébourg Tourist Office for allowing us to publish their material.

Today little visual evidence remains to indicate the presence of a once thriving underground ironstone working in the area around Irthlingborough, in mid-Northamptonshire. Indeed, many of the local inhabitants are quite unaware of the existence of the mine, which became one of the most extensive and up-to-date mechanised workings of its kind in the country. When the mine closed in 1965 the pillar-and-stall workings extended over an area of approximately 2 square miles, (5 square kilometres) and a total output of over 10 million tons had been extracted during its 50-year life.

The seam of iron known as the Northampton Sand Ironstone occurs in the Jurassic system just above the Upper Lias Clay. It lies between Lincoln in the north, and Towcester in the south, a distance of some 80 miles (129km), with a maximum width of 20 miles (32km). It was exploited by Iron Age man, while the Romans later set up furnaces in various forested parts of Northamptonshire. Production continued until Elizabethan times, when restrictions placed on charcoal burning, to preserve timber, probably brought about its decline. The stone, however, continued to be used for building until, in the 1850's, as a result of the material being displayed at the Great Exhibition, along with other economic minerals of the British Isles, interest was again shown in its iron-making potential. Within a few years many shallow quarries had opened, working the seam along the outcrop, and by the turn of this century much of the shallower material had either been worked out or earmarked by the various iron companies.

(LOCATION PLAN) Fig:1

Much of the stone was smelted in small blast furnaces on site, but in 1914 the Ebbw Vale Steel Iron & Coal Company, later known locally as the 'Edd Vale', came into the area to look for a supply of iron to feed its blast furnaces at Ebbw Vale in Wales, when supplies of Spanish ore were in jeopardy. As relative late-comers to the field they were forced to consider the deeper beds, and set about planning an underground mine and ore preparation plant to be sited in the valley of the river Nene at Irthlingborough.

A tunnel was opened into the side of the valley at a level below the ironstone seam, and driven at a rising gradient of 1 in 200 to find the seam at a point some three-quarters of a mile (1.2km) to the north where the mine workings were opened up. The line and position of the tunnel was largely established by the Company's mining Consultant, Professor Henry Louis, in a single afternoon's walk over the area in December 1914. He described his ideas in a letter to the

Managing director two or three days later, and it is remarkable to note how close the actual layout kept to his first assessment. The tunnel was brick lined throughout its length and supported two 3-ft (1m) tramways. All the electrical power was carried on hangers along its side from a surface generating plant to an underground battery charging station. The main haulage was achieved by trolley locomotives powered by overhead wires. In the bottom of the tunnel a drainage channel was constructed, and this drain still runs today. A walkway was provided along the side where there were manholes at intervals to be used as refuges as trains passed. Two shafts were sunk before constructing the main tunnel so that drivages could be made from several points along its route. A fan house was built above one of these shafts, and this was used to ventilate the mine during the whole of its life. The air, 60,000 cubic feet (1698 cubic metres) per minute, was sucked round the mine and kept to its destined course by walls built of ironstone or brick, known as 'stoppings'.

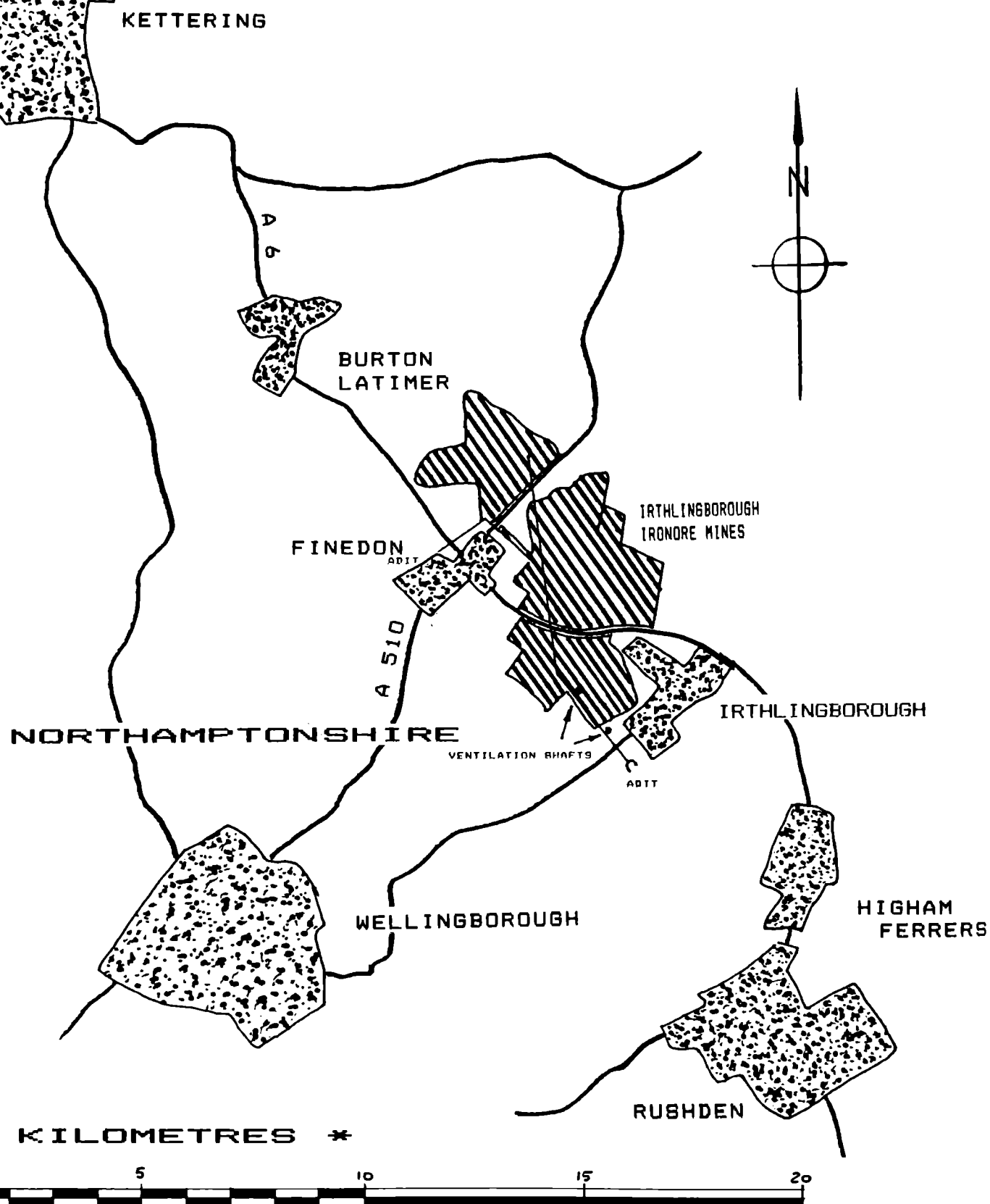
(MAIN TUNNEL CROSS-SECTION) Fig:2

METHODS OF WORKING

Conditions underground were quite pleasant; there was plenty of head room, no fear of gas, a constant moderate temperature summer and winter and a roof which was relatively stable. In working the seam about 1 foot (0.3 metres) of stone was left above to form a strong roof, keeping other supports to a minimum. The seam was worked by the pillar-and-stall method. Headings 12-14 feet (3.6 - 4.2 metres) wide were driven 60 feet (18 metres) apart, with crosscuts at intervals to leave roughly square pillars. When the workings reached the boundaries of the estate the direction of working was reversed and the process known as 'robbing' began. Two headings were driven into each pillar and as much of the rib side was extracted as could be done safely, leaving extremely small pillars which would collapse when the roof supports were removed. This whole process resulted in a total ore extraction of 92%. Because the mine was relatively shallow, with between 50 and 100 feet (15 - 30 metres) of cover, the results of robbing, particularly in the shallower areas, were immediately evident at the surface where subsidence left potholes. The areas likely to be so affected would be sown with grass, and the fields grazed until the land had settled. Today most of the potholes have been filled and the land returned to normal agricultural cultivation; a slight lowering of the field levels is all that remains. Experiments into various methods of extracting the pillars to avoid too much surface potholing were carried out right up to closure, but the balance between getting out as much of the ore as possible while still leaving a workable surface was very hard to achieve.

Fig. 1

LOCATION PLAN



MAIN TUNNEL CROSS-SECTION

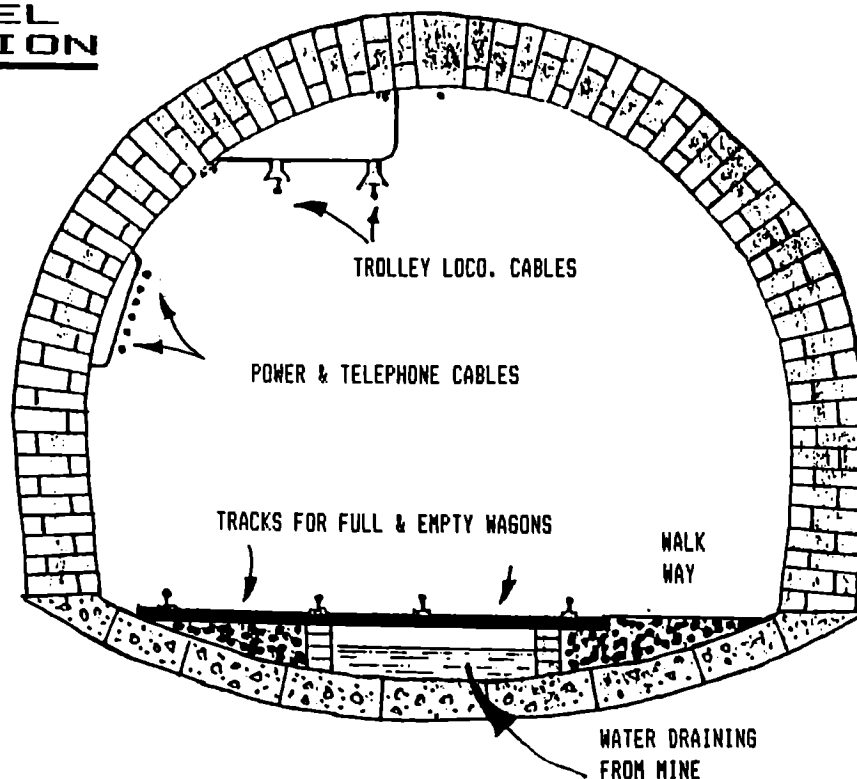


Fig. 2

The productive history of the mine falls into three fairly distinct periods. Firstly from 1918 to 1938, when the stone was got and loaded into wagons or trams by hand; secondly, from 1938 to 1946, when hand held electric drills were provided to drill shot holes, and finally, from 1946 to 1965, when much of the stone was got and loaded by mechanical methods.

1916 TO 1938. THE HAND MINING ERA.

The electricity in the underground sub-station was mainly to provide capacity for charging the small battery haulage locomotives, and none was available at the working faces. At the outset the ore was got by the miner using a hand ratchet machine to drill one or two holes at a time, as required, and charging them with explosives. This was both exhausting and slow, and in 1920, to increase output, 9 electrically operated Blakett face drilling rigs were bought, powered by batteries. Each machine, operated on an afternoon shift, could drill about 8 headings of 12 holes each, blasting the stone down for miners to load the following day. Unfortunately, this method of drilling a whole face in one operation had the drawback of fragmenting the stone to such an extent that a greater proportion of 'fines' was created. These 'fines' were stones of less than about three-quarters of an inch (2 cm) cube size which the ore preparation plant could not utilise due to their tendency to impede the flow of air. In the early days, and up to 1938, the fines had to be left in the mine, and all the old workings have piles of them along the sides of the headings.

Until about 1936 output was very spasmodic; in 1924, with the onset of the Depression, there was no production at all, and in the following year only 85 men, including surface workers were employed. All but one of the Blakett drills were stowed in an old working and forgotten. Miners reverted to drilling holes with a hand ratchet machine which was set up on a vertical standard by clamping between roof and floor. One or two holes were drilled at a time, each about

3 to 4 feet (1.0 - 1.20 m) deep, and charged with explosives paid for by the miners out of their wages. Each miner and his mate, or 'helper', together did all the work at the face, drilling holes, blasting, timbering where necessary, laying track and loading into trams using large forks which allowed the fines to fall through.

Each tram held about three and three-quarters of a ton of stone, and a miner and helper would fill 2 or 3 trams a day. They would pack the tram with stones around the sides to get in as much as possible, and the miner would chalk on the side his number, and the number of trams filled so far that week, so that the weight could be duly allocated to him.

LOADING TRAMS BY HAND Pl. 1

The men provided their own safety hats, boots, picks, shovels, forks, acetylene lamps and carbide. These lamps, throughout the whole life of the mine, were their normal source of illumination at the face, a naked flame being permissible in this non-gaseous pit.

When a young lad started from school there was always the unofficial initiation ceremony to be undergone. The initiate was asked if he could handle a pick.

"Of course I can."

He was then asked to prove it by hitting a chalk mark on the floor. This he did with unerring accuracy.

"That's easy. What about doing it in the dark?"

"O.K." was the standard reply.

All the miners' lights would go out, the pick was handed over and somehow the lad was relieved of his helmet. The pick came down with a resounding crash, and if the lad had any skill at all he had demolished his expensive hard hat.

Soon after the mine was opened a new entrance, of about 120 steps, was constructed at a point nearer the workings, one mile (1.6km) from the main entrance. The men would enter the mine by this drift and from there they would walk to their

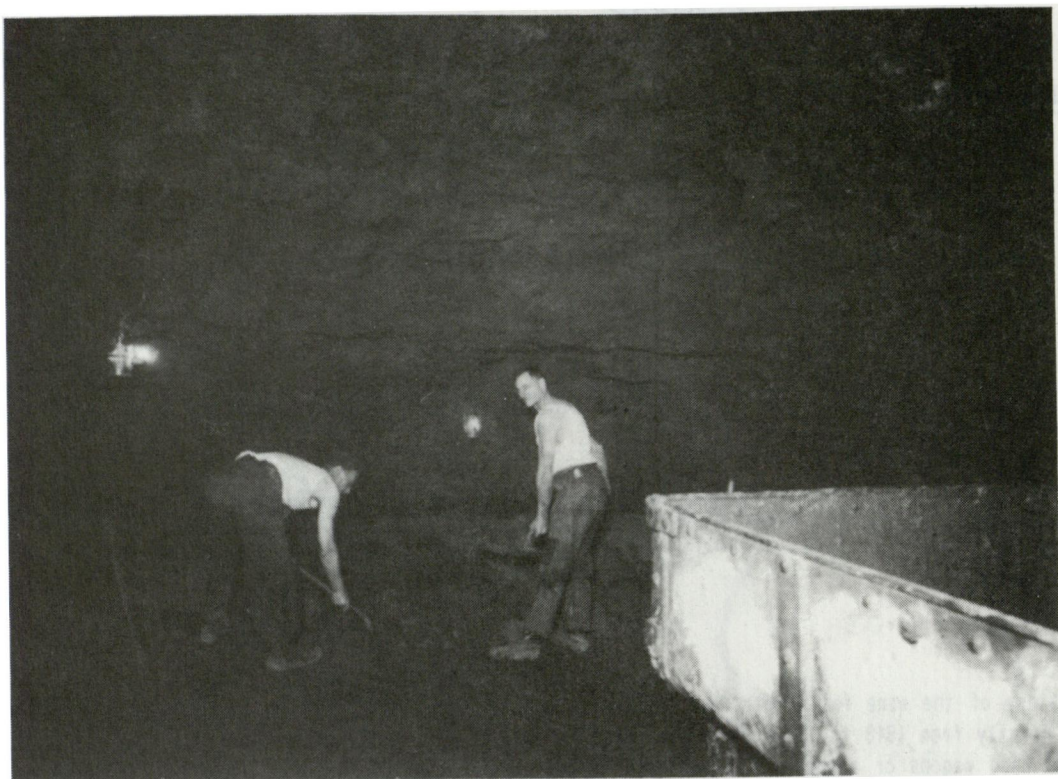


Plate 1 - Loading trams by hand

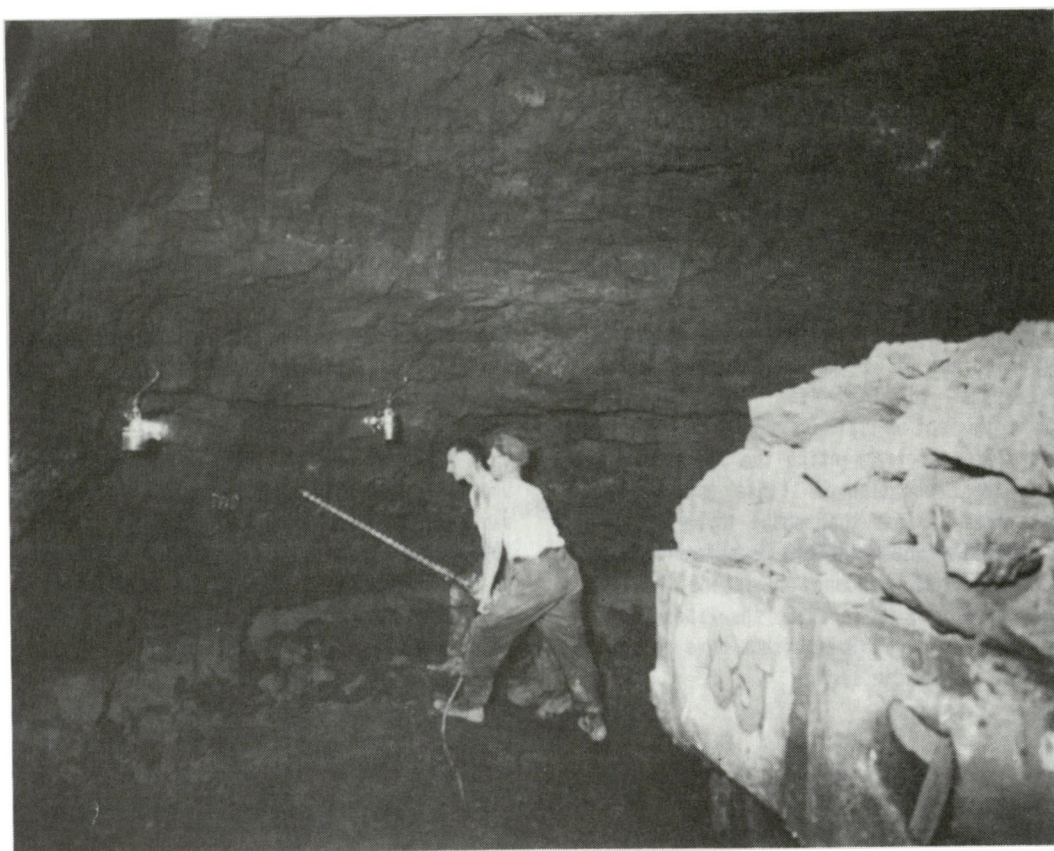
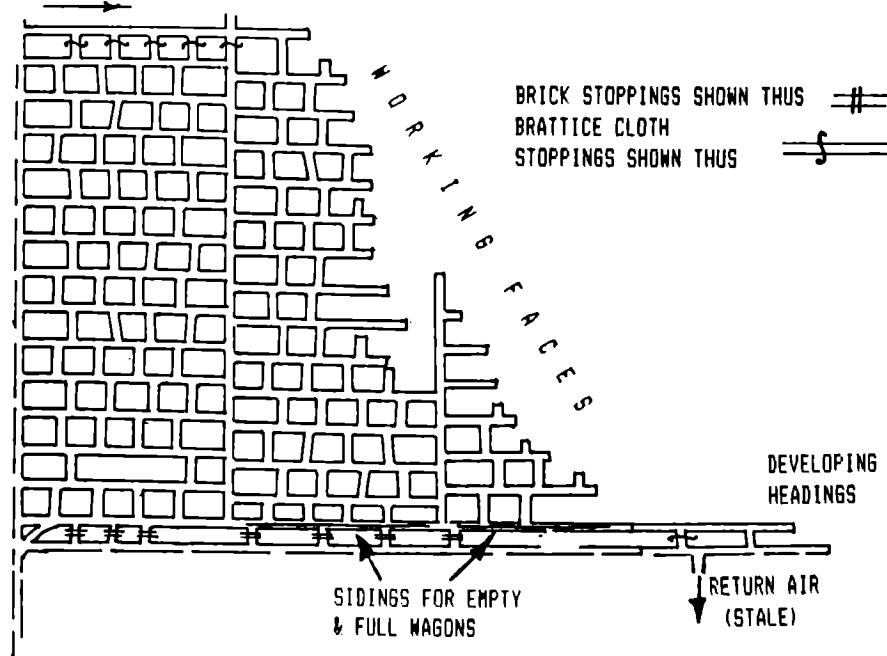


Plate 2 - Drilling face with hand-held electric drill

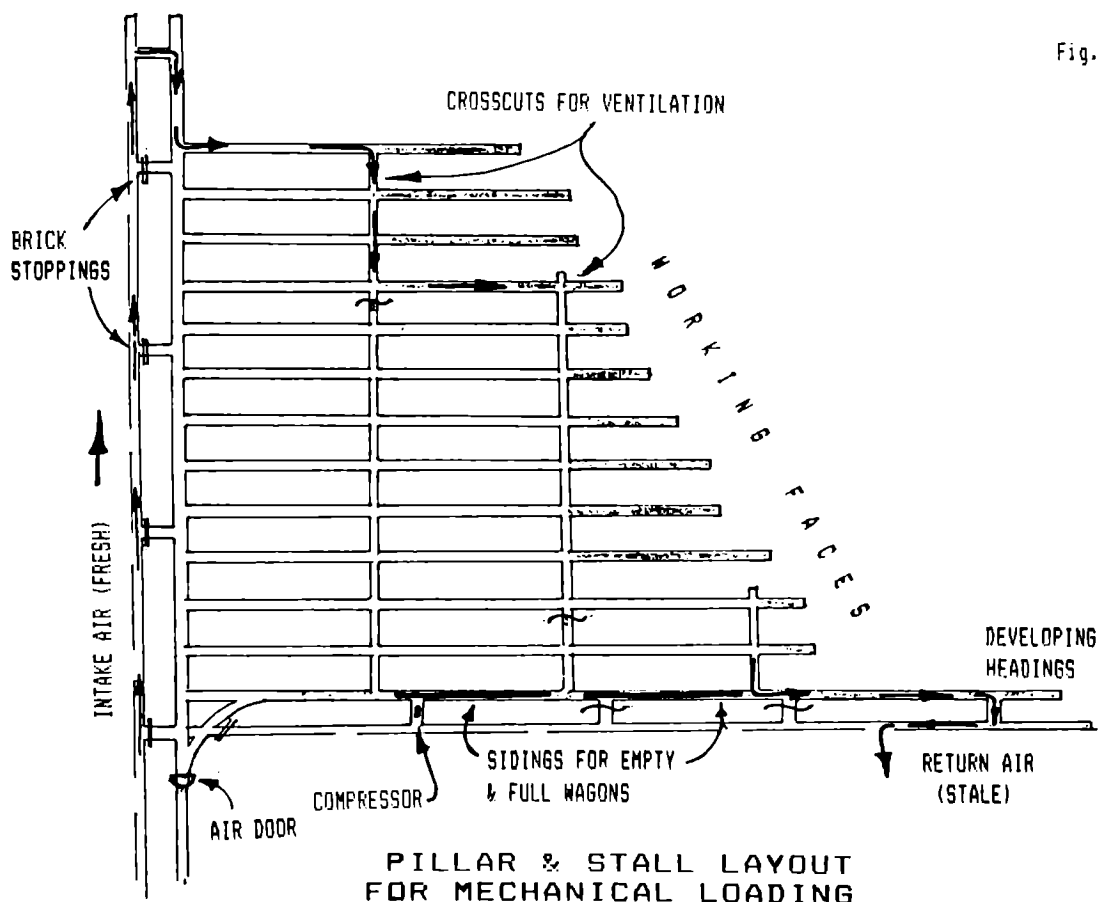
INTAKE AIR (FRESH)

Fig. 3



**PILLAR & STALL LAYOUT
FOR HAND LOADING**

Fig. 4



**PILLAR & STALL LAYOUT
FOR MECHANICAL LOADING**

working place. Later, in about 1950, as the distances increased, a system of man-riding trams was used; these were nothing more than ordinary trams with wooden sleepers as seats.

1938-1946. PARTIAL MECHANISATION.

In 1935 Richard Thomas & Co. bought out the Ebbw Vale Company and began to inject new life into the mine in several ways.

In 1938 a new ore preparation plant was built, in which the ore was 'sintered'. This replaced the old method of calcining, and in addition to giving more consistent results it also meant that the fines were no longer a problem and miners were able to use shovels for the first time to load their trams. This added a further 15% to the available ore.

At the same time the electricity generating plant was closed down and power brought by land line from the local electric company and taken underground to the working faces. Each miner was supplied with a hand-held electric drill for making shot holes. They were 2½ h.p. machines weighing about 40 lbs. (18kg), and were powered by a 250 volt d.c. supply. With the drill the two man team would now make 4 or 5 holes 4ft 6 inches (1.37m) deep, and blast down about 5 to 6 tons of stone, increasing output significantly.

(DRILLING FACE WITH HAND-HELD ELECTRIC DRILL) Pl. 2

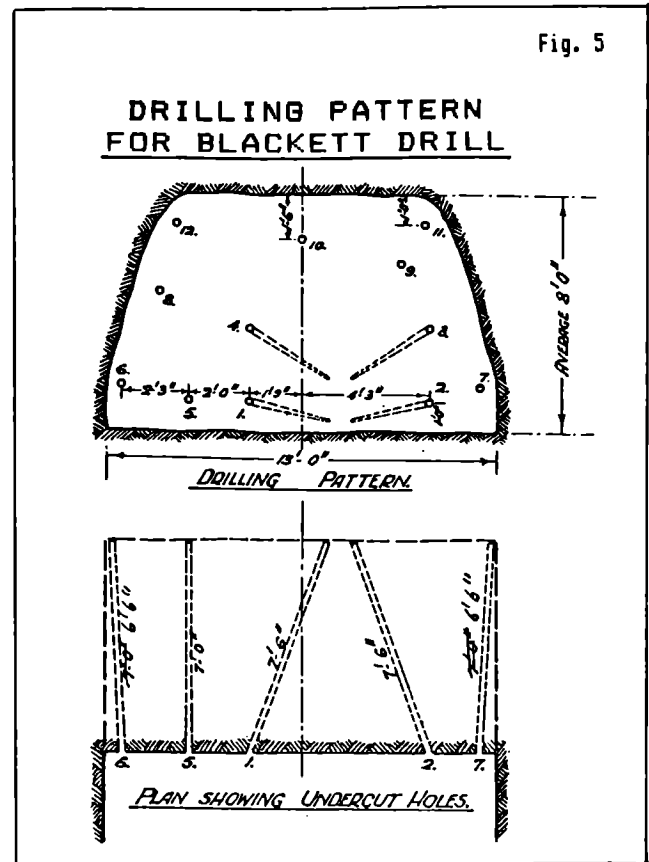
By the outbreak of World War II the mine had developed to the point of almost optimum output with the available equipment, but as ever the lack of suitable labour was one of the most critical factors. However, with the introduction of the Essential Works Order, about 200 men from the local boot and shoe industry were directed to the mine to supplement the existing 200 strong work force, and the mine contributed considerably towards the war effort throughout this period. Nevertheless, absenteeism was very high during those years, partly because the work was very strenuous and most unsuited to workers from the local shoe factories (the principal trade in the area). When the Order was lifted at the end of the war the number of miners dropped significantly to pre-war levels, output went down as a result and something had to be done. The two solutions adopted, both of which proved very satisfactory, were firstly the development of a mechanised mining system, and secondly the introduction of foreign labour.

(DIAGRAM OF HAND AND MECHANICAL PILLAR-AND- STALL LAYOUTS)

1946-1965. FULL MECHANISATION.

The old pillar-and-stall layout was unsatisfactory for mechanical loaders which required long straight drivages to be efficient. The workings were therefore laid out in revised form with elongated pillars. Roads were driven 13 feet (4.0m) wide, with cross cuts for ventilation 9 feet (2.7m) wide at intervals of 240 feet (73m). Whereas in the past a district overseen by a deputy required up to 20 miners, now one district would be worked by two teams, each

Fig. 5



consisting of six men, usually with two men operating a drill, one shotfirer, two men loading with a mechanical loader and one road-man. The two drillers, who would be experienced miners, would drill a fixed pattern of holes with their Blackett machine; these machines had now been taken out of retirement, fitted with 6 h.p. motors and converted to mains electricity. The complete success of the round depended upon the number of holes and the accuracy of their position; this was established after several months of experimentation. It was eventually found that four holes, forming a wedge called the 'box-cut', should be drilled to a depth of 7ft 6in (2.3m), and the 'easers and trimmers' round the side should be drilled to correspondingly shorter depths to give a round which would advance the drivage by 6 feet (2m). All the holes were charged with explosive and stemmed with clay from the drillings. The charge was then exploded by means of a Schaffler exploder, using instantaneous detonators for the box-cut, a slight delay on the four bottom holes and a further short delay for the remainder of the round, in order to obtain the best fragmentation for handling by the mechanical shovel; the fines produced were now no longer a problem. The third member of the team was the shotfirer whose job was to set the charges and fire the rounds, each of which needed 13lbs (5.8kg) of explosive. Unlike the hand miner, who would use his judgement as to where to put his shots and how much powder to use, this miner had to work to strictly laid down procedures. Almost invariably he would bring down 40 tons of rock at a time.

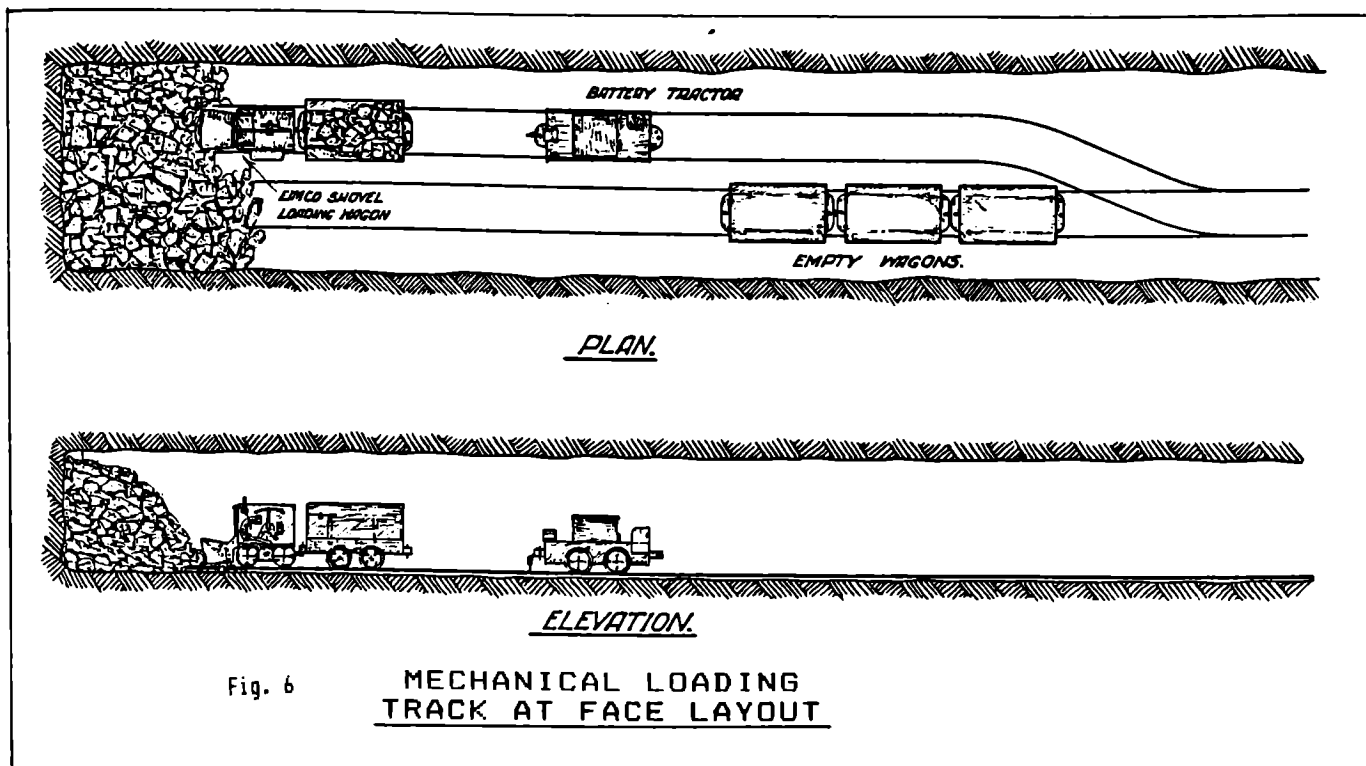


Fig. 6

MECHANICAL LOADING TRACK AT FACE LAYOUT

(DRILLING FACE WITH BLACKETT DRILLING RIG) Pl. 3

The machine used to load the stone was an Eimco rocker shovel powered by compressed air, and operated by one man using two simple controls, one for forwards and backwards motion and one for lifting and lowering the bucket. Another man would hold the flexible hose clear of any obstructions. The bucket was dug into the heap of stone and by forward and backward movement of the control a bucketful was lifted out of the heap and thrown over on the rockers into a waiting tram behind. The machine was mounted on the normal 3ft (1m) gauge track and could be swung quite easily from side to side on its bogey to gather material from either side. Although it was an extremely noisy machine it was most efficient. It was imported from America, where it had proved very successful in tunnelling, but had never been proven in general production work before; it was found to be most adequate and robust. Of the eight machines bought in 1947, six were still working satisfactorily in 1965, the other two being used as standby machines.

(DRILLING PATTERN DIAGRAM AND TRACK LAYOUT) Fig. 5/6

The tracks at the face were extended into the heap by means of a telescopic arrangement. When the heading had advanced 12 feet (3.60m), that is two firings of 6 feet (1.80m), the plate layers, or roadmen, would enter to lay another length of rail and extend the compressor pipe. The roadmen were usually older miners unable to take on the more strenuous task of hand loading any more. They had the use of small compressed air picks to loosen the floor when necessary, to maintain a level track and to ensure headroom for the loader bucket.

The output per man shift by this mechanised system rose

greatly. Under ideal conditions, with some record breaking runs, production figures in excess of 30 tons were occasionally achieved.

There were usually about 4 or 5 mechanical teams working in the mine at any time, although this would vary on occasions according to the output required and the number of trained men available.

Work was usually divided into two eight-hour shifts, in the mornings from 7am to 3pm, and in the afternoons from 2pm to 10pm. Hand mining also continued to be used in robbing areas where it was thought that the noise of the mechanical loader would prove hazardous to the men, who would not be able to hear any impending roof movement. Eventually a method was devised of taking a second cut in order to extract some of the pillars safely by mechanical means.

The miners, and particularly the loader teams, were backed up by a considerable outside maintenance force of blacksmiths to sharpen drills, electricians to lay and extend electric cable, engineers to service machinery, fitters, carpenters and bricklayers; nearly all work at the mine was done by direct labour, requiring quite an assortment of craftsmen.

The air compressors were static machines which were shifted every twelve months or so as the workings progressed. The air was conveyed through 4in (10cm) steel pipes set in the sides of the floor below rail level. Valves were placed at regular intervals to isolate the parts not in use. The company had four of these compressors but usually at least one of them would be at the surface undergoing a thorough overhaul. Each compressor would usually serve two loader teams, or one district.

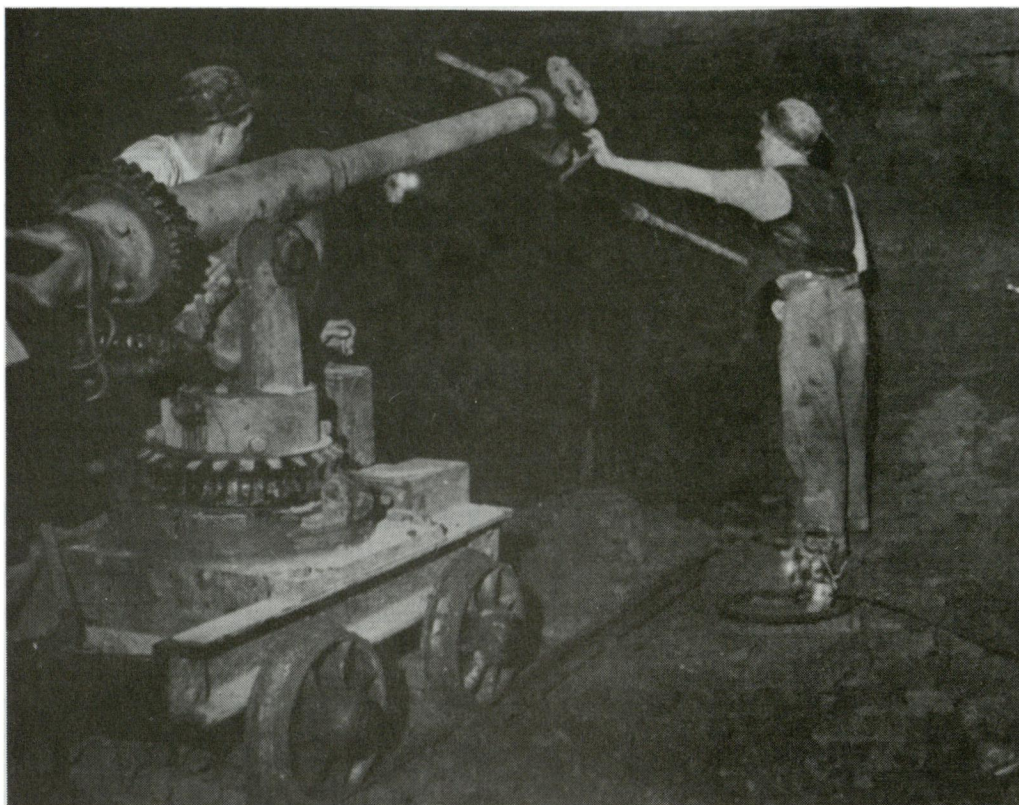


Plate 3 - Drilling face with Blackett Drilling rig

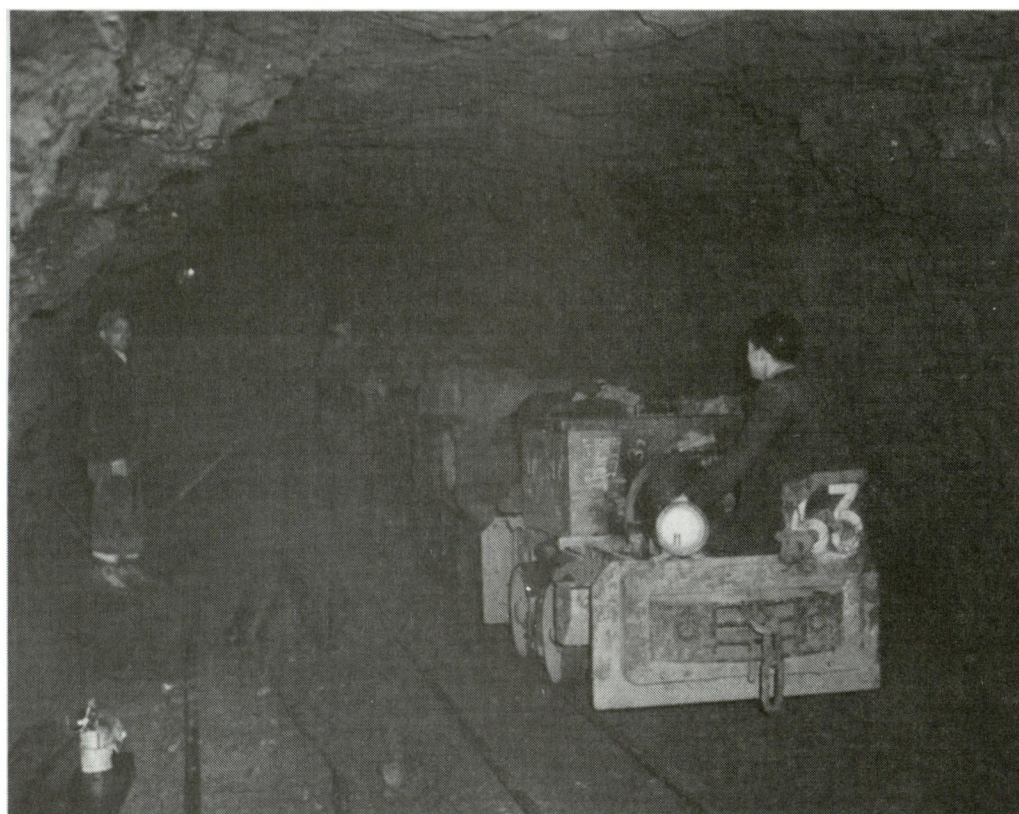


Plate 4 - Battery 'tractor' loco for filling by 'Eimco' mechanical loader

In 1947, when the mechanical system was running smoothly, the company recruited labour from a local camp housing men from the Polish Resettlement Corps, who were being demobilised. The manager spoke to a packed hall about the mine and the advantages of working underground. At first reluctant to take on this type of work, twelve men were invited to the mine to inspect working conditions. Greatly impressed, they reported back to their colleagues and eventually 60 men began work. They were soon joined by Estonians, Lithuanians, Latvians and Czechs. From the outset they proved their worth, mixing well with the British miners and working extremely hard. This source of labour was so important to the Company that they leased a large local residential building for a Company hostel, and to many men this became their permanent home. Unfortunately, the number of miners still declined, reaching such a critical state in 1956 that the management again had to seek more foreign labour. This time they brought in 30 workers from the Naples area of southern Italy on one year contracts. They also spent £40,000, in those days a considerable sum of money, on upgrading the hostel to hotel status.

(BATTERY 'TRACTOR' LOCO PLACING EMPTY TRAM FOR
FILLING BY 'EIMCO' MECHANICAL LOADER) Pl. 4

TRANSPORT

Small battery locos, called 'tractors', hauled the loaded trams from the working faces to nearby sidings for collection by the main haulage locomotives. At the end of each shift they were taken to an underground charging station where the batteries were recharged ready for the next day.

When about 20 loaded trams had collected on the partings, a

trolley locomotive would haul the train to the surface, a distance of 2 to 3 miles (3.2 - 4.8km), but ever increasing as the workings extended further from Irthlingborough. These locos were powered by an overhead 250-volt d.c. supply to two 40 h.p. motors, with return through the rails. Each driver was supported by a 'rope-runner' who stood on the buffer of the last tram. His job was to signal to the driver to stop if any of the trams derailed, and to jump off the moving train to close any air doors which they passed through. The locos were fitted with boxes containing sand which was sprinkled on the rails to form a grip when starting, or climbing a gradient. A man attempting to couple a train to a loco standing on sand could receive a considerable electric shock. The system was eventually banned by the Mines Inspectorate, and shortly before closure the three main locos were converted to battery operation, a design unique to Irthlingborough.

CLOSURE

Due to various economic factors the ore eventually became too expensive to mine. In September 1965, the last train of ore was brought to the surface and during the next 18 months the mine was gradually closed down. All the machinery and rails were drawn out, and all adits and shafts bricked up or stowed solid. Today all that remains to show that there ever was a mine at Irthlingborough are the bricked up adits at Finedon, almost inaccessible and overgrown, the odd farm gate made from old drilling rods, a few places where the field levels have dropped as a result of robbing and one or two remote subsidence holes. The main adit at Irthlingborough has been completely landscaped, but the names 'Adit View', 'The Sidings' and 'Ebbw Vale Close', given to roads on the new residential estate which has sprung up on the site, serve as a continuing reminder of the presence of a once thriving industry.

KRAFTWERK NORD WEST BUNKER, EPERLECQUES, FRANCE.

R. Hautefeuille and H. de Megille.

Although this site was built only for the launching of V2's, it is necessary to understand the V1 so as to compare them. The F2676 or FI103, also known as the V1, was developed for the Luftwaffe from 1942, and although it was designed well after the V2, it was fired on London as early as 13 June 1944.

The main features of the V1, the fore-runner of the present day cruise missile, were as follows;

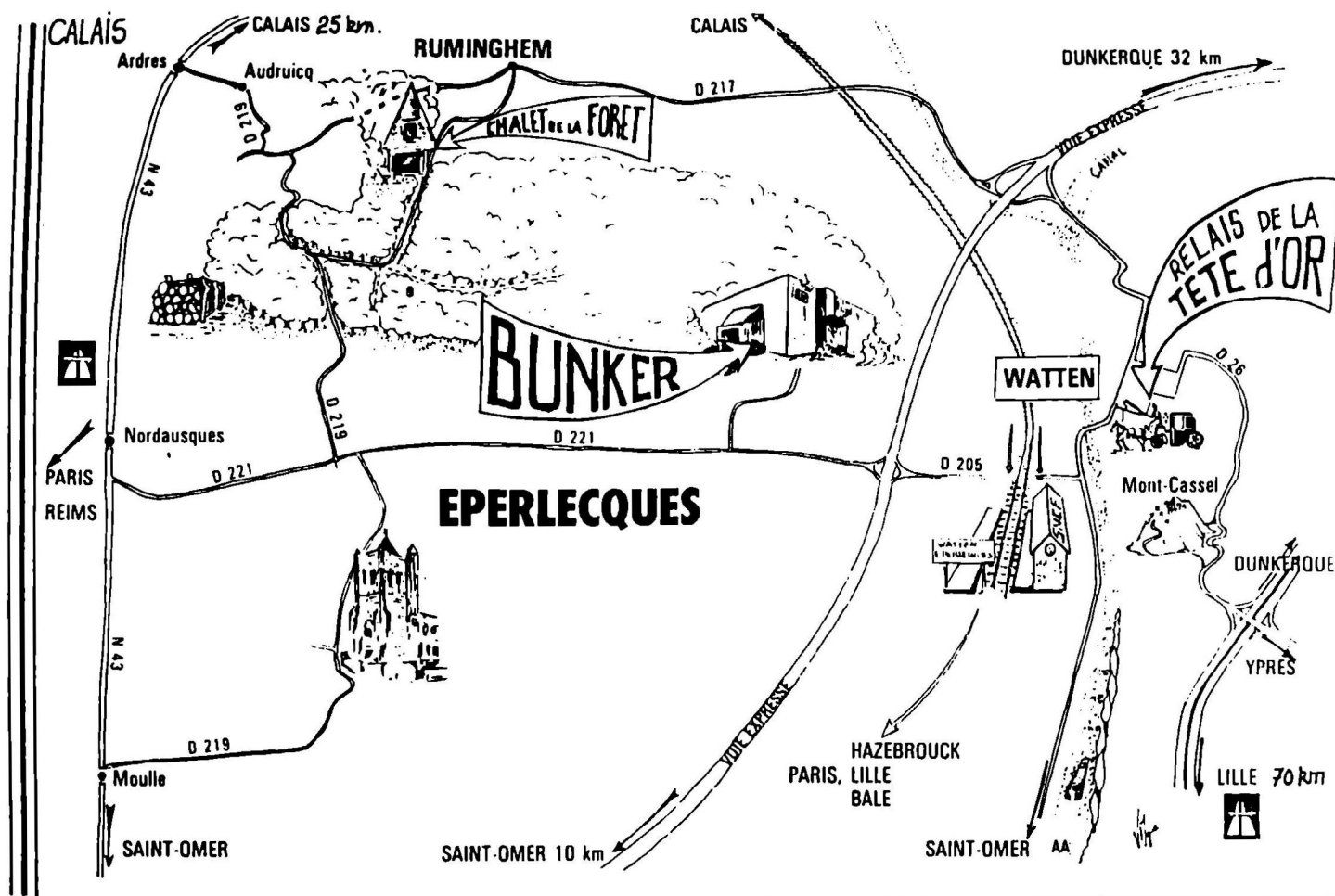
Length;	8.03 metres
Wing-span;	5.39 metres
Weight of explosives;	1,800lbs
Speed;	approx. 650 km per hour
Radius of action;	250 to 300 kms

This weapon was powered by an impulse engine fuelled with kerosene and launched from a ramp 45 metres in length. The V1 rocket was hooked on to a piston propelled inside a tube by means of high pressure steam generated by the chemical reaction of hydrogen peroxide and permanganate.

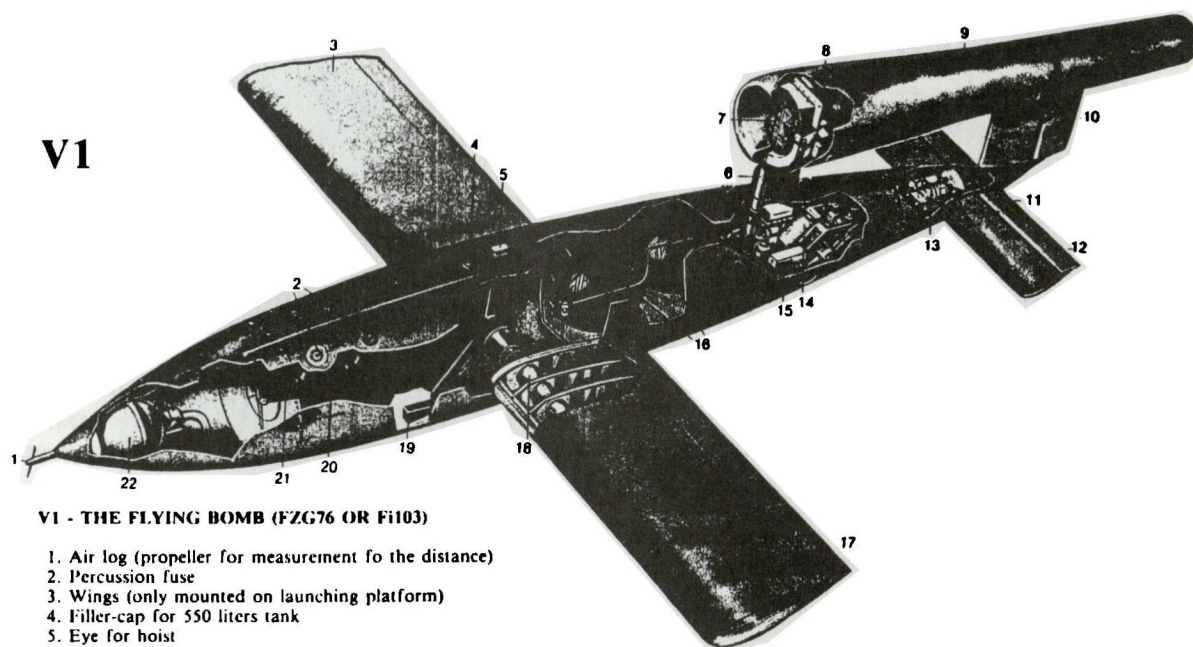
Altogether 22,384 V1's were launched between June 1944 and March 1945, including 10,492 against Britain (mainly London) and 11,892 against Belgium (Antwerp, Liege and Brussels). It is estimated that about 59% hit their target areas.

The A4 or V2 was a far more sophisticated weapon. It was the fore-runner of all modern rockets

Length;	14.03 metres
Diameter;	1.65 metres
Weight (on launching);	12 tons
Carrying capacity;	1 ton maximum
Maximum speed;	5472 km per hour
Range;	270-350 kms
Engine thrust;	25 tons

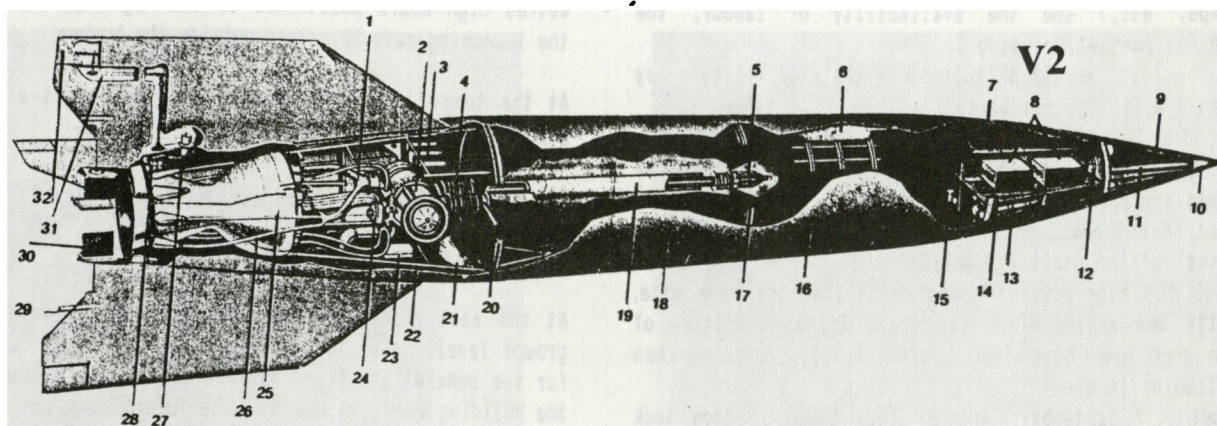


V1



V1 - THE FLYING BOMB (FZG76 OR Fi103)

1. Air log (propeller for measurement of the distance)
2. Percussion fuse
3. Wings (only mounted on launching platform)
4. Filler-cap for 550 liters tank
5. Eye for hoist
6. Propellant line
7. Nine injectors for propellant
8. Flap-valves with springs
9. Pulse-jet engine
10. Direction rudder
11. Small blast of strips to initiate the diving phase
12. Pitch rudder
13. Main gyro
14. Dry battery
15. Compressed air tank (wire strengthened)
16. No wing flap
17. Tubular spar of the wings
18. Separating bolts
19. 847 kilos of various explosives
20. Main ignition set
21. Main compass for monitoring of the gyro



V2 - BREAKTHROUGH TOWARDS SPACE CONQUEST

- | | |
|---|--|
| 1. Main fuel feedline | 17. Alcohol feeder |
| 2. Turbopump (alcohol and liquid oxygen) | 18. Oxidiser tank (about 4000 liters liquid oxygen at minus 180°C) |
| 3. Compressed air bottles | 19. Insulated feeder |
| 4. Expansion bellows | 20. Fuel feedline towards turbopump |
| 5. Principal fuel valve | 21. Hydrogen peroxide tank |
| 6. Glaswool | 22. Engine frame |
| 7. Fore connecting ring | 23. Liquid catalyst tank |
| 8. Pilotage and guidance electronic device | 24. Mixing chamber |
| 9. Warhead | 25. Combustion chamber |
| 10. Head of the percussion fuse | 26. Cooling alcohol line |
| 11. Fuse conduit | 27. Trimvane motors |
| 12. Electronic main part of the percussion fuse | 28. Hydraulic servomotors |
| 13. Compressed nitrogen bottle | 29. Antennas |
| 14. Assembly plate | 30. Jet rudders |
| 15. Guidance gyros | 31. Linkage of trim rudders |
| 16. Fuel tank (about 4000 liters of alcohol at 75%) | 32. Aerodynamic rudders |

The fuel was ethanol (ethyl alcohol) and the oxidiser was liquid oxygen fed into the combustion chamber by a turbo pump driven, as was the case for the V1, by the chemical reaction of hydrogen peroxide and permanganate. The guidance system was controlled either by radio or mainly through a system of integrated accelerometer gyroscopes, the earliest example of inertia platforms.

The first V2 was fired on Paris on the morning of 8 September 1944, but the great majority, 3,170 altogether, were directed against London (1,403) and Antwerp (1,664).

During the first stage of construction (March-September 1943), the majority of the work force was composed of free labourers, labour conscripts from the neighbouring area and members of the S.T.O. (Compulsory Labour Service). Their total number can be estimated at around 3,000, working day and night in floodlight. They worked 12 hour shifts with a break at meal-time.

After the bombing raid of 27 August 1943, when work was resumed in November, the German authorities used a great number of prisoners, Russians, Poles, Czechs, some Belgian prisoners (political and non-political) and a few Dutch. All were kept in neighbouring camps under harsh discipline. A considerable number of Frenchmen (especially S.T.O.) went on working here.

The Bunker, a huge towering block of concrete became listed as a historical monument in 1985. However, a few past historical facts should be noted:

1930: A department was created in Berlin, specializing in research on liquid fuelled rockets for military purposes, headed by Captain W. Dornberger, soon to be joined by W. Von Braun and many others.

1936: The Peenemünde Research Centre was started on the shores of the Baltic Sea.

1930-42: Research and development of A1, A2, A3, A5 rockets and ultimately A4, also known as V2.

1942:

3 October; The V2 was successfully launched for the first time.

22 December; Hitler ordered the construction of two bunkers for the launching of V2's, the first one to be started in the Pas-de-Calais as a matter of urgency.

28-30 December; A special mission inspected the St. Omer area and chose Eperlecques as the site for the first bunker, close enough to England without being too near the Channel coast and to other means of communication (railways, canals), its situation on the reverse slope of a large forest being also suitable.

1943:

January-February; Experts from Peenemünde and the Todt Organisation (TO) drew up plans for the bunker and named it "Kraftwerk Nord West" (KNW).

Late March; An army of labourers and earth moving equipment took over the site, the rate of progress being truly amazing due to advanced mechanisation (excavators, concrete plants

and pumps, etc.) and the availability of labour, the deadline for completion being 31 October 1943, 16 May; The first aerial photograph of the site was taken by a British R.A.F. reconnaissance flight, 29 June; The Defence Committee of the British War Cabinet, chaired by Winston Churchill, decided on the attack of Peenemünde and Eperlecques, 27 August; First bombing raid on Eperlecques by 185 'Flying Fortresses' of the 8th U.S.A.A.F. from 18.46 to 19.42 hours, 366 2,000 lbs high-powered bombs devastated the huge site, especially the northern section where large quantities of concrete had just been laid. Unfortunately, many workmen were killed or injured, 30 August - 7 September; Another four bombing raids took place, the Todt Organisation deemed the northern section irretrievably lost, September-October; The T.O. investigated and decided to complete the liquid oxygen factory on a new plan in the southern section of the site. A new construction technique would be used; the roof 5 metres thick, would be constructed in sections gradually raised by hydraulic jacks, while the outside walls were being built, November; Work resumed on the site,

1944;

January; The main building work was completed on the bunker housing the liquid oxygen factory,

2 February - 25 August; Twenty new bombing raids took place including two (19 June and 27 July) with 12,000 lbs "Tallboy" bombs,

6 September; The area was liberated by Canadian troops and a number of Allied missions inspected the site including those of Colonel Sanders and of the British Bombing Research Mission,

1945;

January; Last bombing raids by USAAF to test new bombs,

1974; The site opened to the public,

1985; The Eperlecques Bunker became listed as an historical monument,

1988; Both 213 ton doors were back in working order for the first time,

The south face of the bunker where the liquid oxygen factory is located has an impressive concrete wall. The bunker measures 75 metres in length, 35 metres in width, 22 metres in height (the visible part), and an overall height of 33 metres. As it stands today the bunker is only just over a third of the size it would have been had it been completed,

At the centre of this face a pentagonal structure can be seen, which is in fact the lower part of the control tower of the original bunker, the stage of construction which had been reached by the 27th August 1943, the day of the first bombing raid,

From this control tower the V2 rockets would have been fired, after being brought out through the great 17.50

metres high doors positioned to the right and left, up to the launching pads 30 metres outside the bunker,

At the top of the wall can be seen the impact of a heavy weight American bomb tested in early 1945,

All along this face a number of holes are visible, they were meant as air intakes for the bunker itself and the compressor units that produced liquid oxygen,

At the east corner of the bunker a shelter was built at ground level after the first bombing raid 1943, presumably for the general staff and workmen from firms taking part in the building work and also for the future garrison,

When facing this eastern side, and on the right, a projecting canopy sheltering the access for a standard gauge railway track linking KNW to the Calais - Lille railway line can be seen. The gradient of the roof was meant as a bomb deflector. This entrance was secured by a specially designed door,

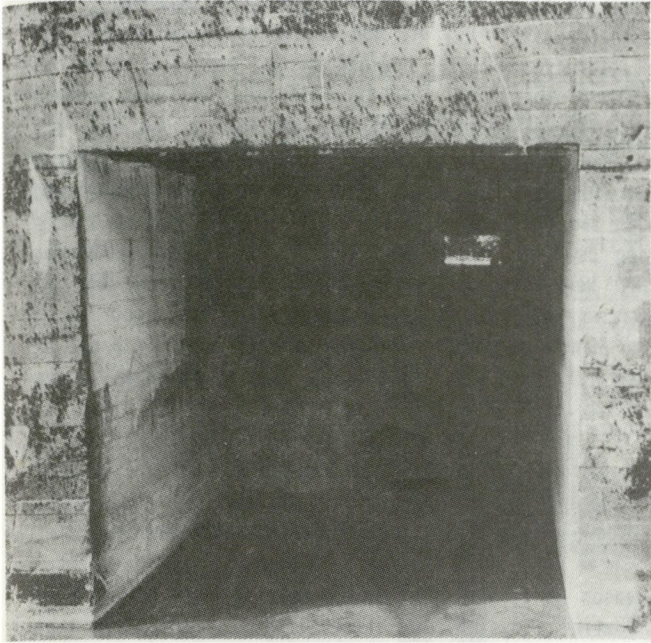
On the wall is a plaque commemorating the sacrifice of Squadron Leader René Mouchotte of the Free French Air Force whose fighter aircraft was shot down over the North Sea as he was escorting the American bombers during the bombing raid of August 1943,

Beyond the uncompleted 5 metres thick wall which is part of the perimeter of the early bunker, and towards the north east, another shelter was built after the August 1943 bombing raid on the spot where one of the two railway tracks to the early bunker should have been. Some of the superstructure was badly damaged, exposing concrete girders. The eastern entrances to the bunker project forward so as to be sheltered by a concrete roof 3.50 metres thick,

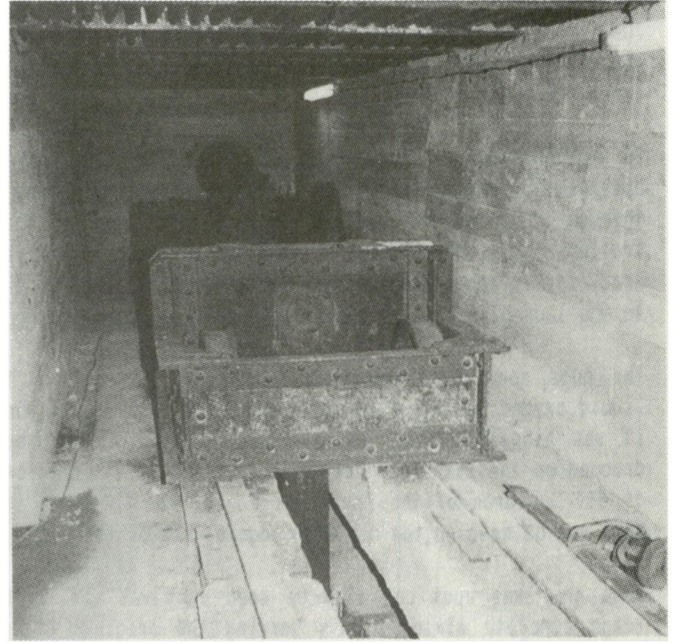
The space between the two railway passages was designed to accommodate both the 2 metres thick tunnel doors when they were pulled aside. These doors were eventually used to seal both ends of the one tunnel mentioned earlier,

Above the north side of the bunker is what appears to be a raised concrete platform below the forest, and it is possible to get an overall view of the northern section of the site, overlooked by the imposing north face of the bunker. The platform is the top of the original bunker wall, 11 metres high, but unfinished, in fact less than half its specified height of 23 metres on top of which the roof, 5 metres thick, had to be built. The thickness of the wall is also 5 metres. From these details it is easy to imagine to what gigantic proportions the original bunker would have been built,

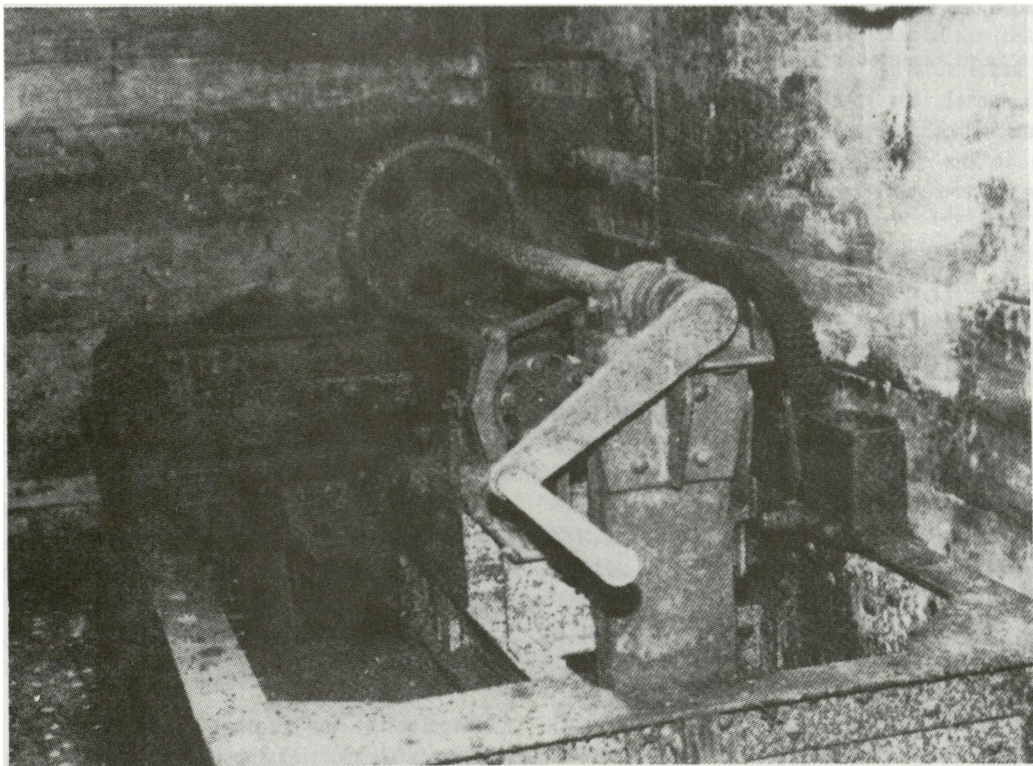
From this platform, one can look down at the gallery of the first of the railway tracks and then on the same level, the area reserved for road vehicles, a storage space and further on the second railway gallery and finally the liquid oxygen storage area sheltered by a roof 2 metres above. Nearly the whole of this area was the second level floor to be used as vertical storage for V2's without their warheads. The section immediately under the roof was to have been 14



Main corridor



Carriage of the 216 ton-door



Door mechanism

metres high with a storage capacity of 120 rockets.

Just opposite is the path left by a high calibre bomb that went through the floor. This can be seen on all photographs taken since August 1943.

On either side of the liquid oxygen storage tank can be observed the lower part of two 21 metres high passages through which the V2 rockets, placed vertically on their trolleys, were transferred to the filling station and made ready for firing before finally being transported outside on to the launching pads on either side of the control tower.

The huge concrete block that landed on the roof of the liquid oxygen storage tank comes from the bunker roof where it was blasted off by the explosion of a "Tallboy" bomb dropped on the 25th July 1944 by one of 15 Lancaster bombers of 617 Squadron of the Royal Air Force. The impact of the bomb can be seen on the northern edge of the bunker roof.

From the same spot can also be seen what was one of the large concrete mixing plants serving the original bunker. Concrete for the present bunker was produced by a plant situated further up which was damaged during numerous bombing raids; all around you can see a number of bags of cement that set on the spot.

The concrete produced by the plant was forced towards the building site by special pumps and transported through pipes some dividing into branches at the end, fitted with swivelling spouts to spread out the concrete. The Germans called this system "spider". The task of finishing and levelling out the concrete was done by some fifteen young Belgians with wheelbarrows or hand barrows carried by two men. A nearby plaque has been erected in memory of them.

Around the north western corner of the site, past the end of the first railway tunnel, the road vehicle area, the second railway tunnel and finally a small zigzag opening, is the western entrance to the garrison bunker. The work on the protection of the western entrance had not been started.

At the entrance to the bunker on the west is a door 6.05 metres high of which only 4 metres can be seen because the tunnel has been partly filled in and raised to a height of 2.50 metres above the underground water level. The door, protected by a 5 metres projecting canopy, is 2.50 metres thick filled in with concrete. It is suspended by two push rods to a four axle carriage geared down to move along a steel track resting on a ledge overhead. The overall weight is estimated at over 216 tonnes.

The height of the hall within is an imposing 22.50 metres, (in fact 25 metres without the filling material), and houses the railway track. Halfway up, three separate levels were presumably meant to receive the liquid oxygen tanks making it possible to load the special carriages through gravity.

To the right is another hall, perpendicular to the first and the same height as the railway tunnel. At the corner of the two halls is a hinge that was meant to support a swivelling door. The second hall has a peculiarity which could only be

explained after the discovery of the original German plans in 1983. Up to 10 metres above ground level, the wall faces have their corners cut off and enable us to determine with some accuracy the level reached by the original bunker at the time of the August 1943 air raid. This hall was in fact one of the two passages running parallel to the east and west sides of the bunker. These halls, 26.75 metres long, 4 metres wide and 17.50 metres high (25 metres at present) led through two openings of similar size to two rolling tracks serving both launching pads. The rockets, when ready for firing, were sent from the central station and came in through an opening fitted with a 1.50 metre thick door (with similar hinges to those carrying the west door) into one of the two halls and were rolled on a special carriage to one of the two pads.

As the doors were positioned inside the bunker, the cutting off of corners was meant to reduce the blast of bombs exploding close to the two large openings outside.

The reason as to why the Germans kept this 25 metres high wall remains a mystery. An interesting explanation is that the cracking columns for the liquefaction of oxygen could have been placed here.

INSIDE THE BUNKER

Beyond is a rectangular room, 18 by 45 metres, which should have housed five Heylandt compressor units each with a capacity of 320 tons/month liquid oxygen, i.e. a total of 1600 tons per month. Taking into account the important wastage through evaporation because of the very low temperature (-182 degrees C) essential to the storage of liquid oxygen, the production was still sufficient to launch approximately 220 V2's every month.

The five stands that were to have supported the compressors still remain. This room is situated several metres above the railway track level and below the room was unused space, indicative of how far work had progressed by August 1943, and which did not fit in with the new installations of the bunker after the plans had been revised.

This new bunker was built from the topmost level to a total height of 33 metres instead of 28 metres for the original bunker.

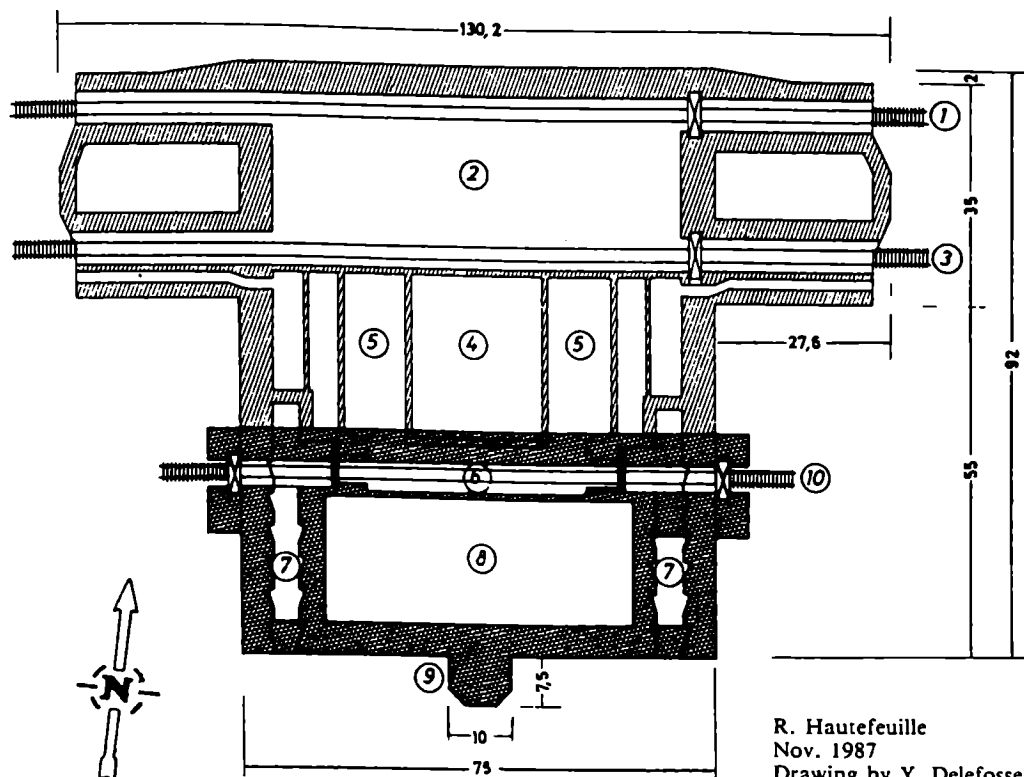
Above the compressor room are several levels housing service rooms, offices and living quarters.

A plaque in memory of five German Jews, killed here in a bombing raid, was erected by their comrades on the south wall before the lower part of the doorway, through which the V2's were to leave the original bunker, was bricked up.

DETAILED INFORMATION

Dimensions of the original bunker: 92 x 75 x 28 metres
Bunker with additional buildings: 99.50 x 130 x 28 metres
Volume of concrete: 120,000 m³ to be poured within four months (1000 m³/day) corresponding to 360,000 tons of various materials requiring 720 trains of 35 wagons each.

Plan of the Bunker «KNW» in Eperlecques for firing A4(V2) as it was designed and partially built (light) and as it was partially completed (dark)



R. Hautefeuille
Nov. 1987
Drawing by Y. Delefosse

Plan at the lever «O» established according to:

- the original drawings of the O.T. (February-March 1943) - Constructions Speciales, pages 54-65
- the plans and analysis of the Central Interpretation Unit (April-August 1943), pages 85-96
- the plans of the Direction du Genie de Lille (1946), pages 130-131

- | | |
|--|--|
| 1. Railway line n°1 | 6. Servicing hall for the preparation of the rockets |
| 2. Area for lorries | 7. Transit halls toward the two outside firing pads |
| 3. Railway line n°2 | 8. Liquid oxygen production plant |
| 4. Liquid oxygen storage | 9. Control tower |
| 5. Transit halls for the rockets toward the servicing hall | 10. Railway line serving the liquid oxygen plant. |

Note: The western doors have not been drawn as their exact location is unknown

(Equivalent in length to the distance between St. Omer and Paris).

On the day of the first air raid, 27th August 1943, about 43,000 m³ had been poured.

Dimensions of the existing bunker: 35 x 75 x 33 metres.

Concrete volume: 41,000 m³.

Finally 84,000 m³ of concrete has been used here (43,000 + 41,000)

Between 27th August 1943 and 25th August 1944, 1,287 bombers attacked KNW and dropped 7,054 bombs, a total weight of 3,682 tonnes.

On the 4th and 6th August 1944, 3 raids by radio controlled Flying Fortresses were carried out to no avail. (Operation Aphrodite)

Another eight large sites for launching V1, V2 and V3's were started or built between the spring and summer of 1943.

For V1's: Lottinghem and Siracourt (Pas de Calais),

Tamerville, Couville and Brecourt (Cherbourg Peninsula).

For V2's: Wizernes (Pas de Calais) and Sottevast (Cherbourg Peninsula)

For V3's: Mimoyecques (Pas de Calais)

CONCLUSION

The various episodes in the construction of the Kraftwerk Nord West Bunker are only one chapter in the long history of battle between "the shell and the armour". Although the armour, in this case high resistance reinforced concrete, seems to have withstood the onslaught of the shell in the shape of a 12,000lbs "Fatboy" bomb, the latter was in fact the victor.

Even if the bunker roof was not broken through, the shock waves and vibrations caused by heavy weight bombs had dire consequences for the compressors helping to produce liquid oxygen. Their performance and reliability was seriously

impaired and on 19th July 1944 the Germans decided to remove the three compressor units already installed and not to use the bunker itself,

A memorial was erected and officially unveiled on 8th May 1966 by the residents of the hamlet of Sart under the guidance of their dean, M. l'Abbe Deloziere, in memory of those who died here and in the destruction of their village,

While they were building KNW at Eperlecques in April 1943, the Germans had decided to build another bunker in the quarry of Helfaut Wizernes, under the code name "Schotterwerk Nord West (SNW)" in order to store 500 V2's. Its measurements would have been 85.50 x 84 x 32 metres, i.e. 80,000 cubic metres of concrete. As KNW was abandoned as a launching site after the August 1943 bombing raid, SNW was chosen to replace KNW. A huge 21 metres high octagonal hall was to shelter 14 rockets being made ready for launching under a concrete dome 71 metres across and 5 metres thick, at the top of the quarry. A vast network of

galleries and underground rooms would have been used for the storage of missiles, fuel and the production of liquid oxygen,

'Let us express a wish that after so much bitter wrangling, the people of Europe may unite and live in harmony, and to quote Goethe in conclusion, "If past generations hide their errors from their descendants, they condemn them to living through the very same errors as their elders". Today the flag of the Council of Europe is raised over this site.'

The Nord Pas de Calais Regional Council has recently decided to make the site of Helfaut Wizernes into a European Museum of World War II, and plan to have it open by 1990. Helfaut Wizernes is south of St. Omer and approximately 10 miles from Eperlecques,

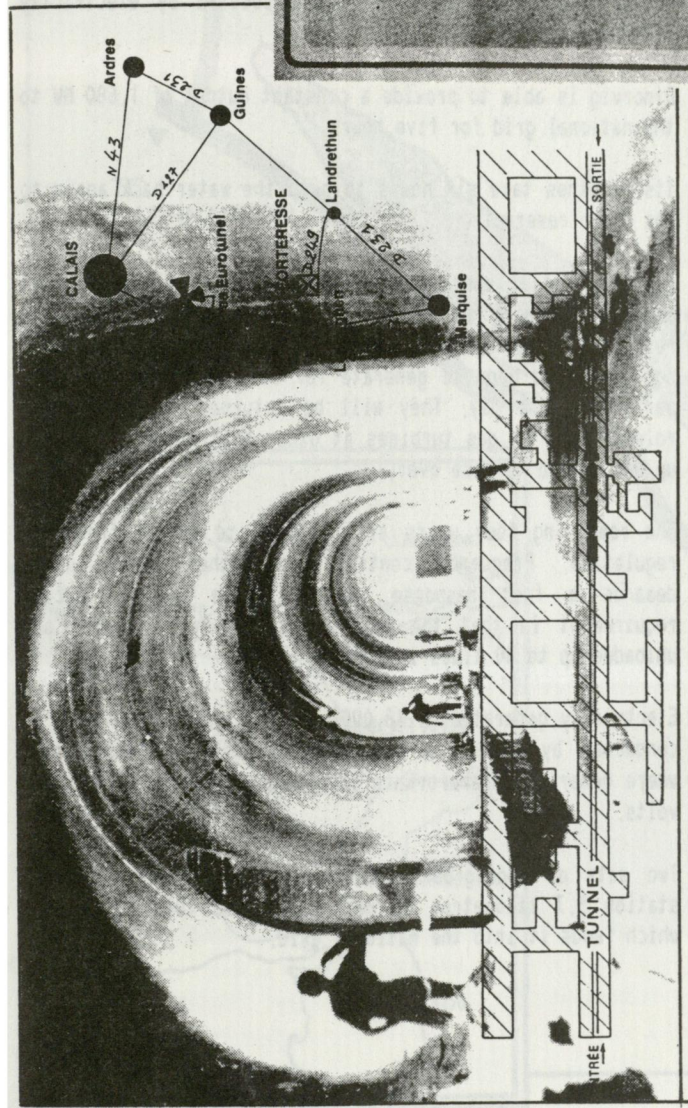
(The Society is grateful to the authors and the Museum for giving permission to allow for a greater part of their guide to be reproduced here.)

EVENING STANDARD



"I'm sorry, that's what Mrs Thatcher's orders are—fill it up!"

This hilarious cartoon appeared in the Evening Standard on 22 September, 1988. The proprietors of the newspaper have kindly given permission for its reproduction in our Bulletin.



1944... The year of the Secret Arms - THE LONDON CANNON

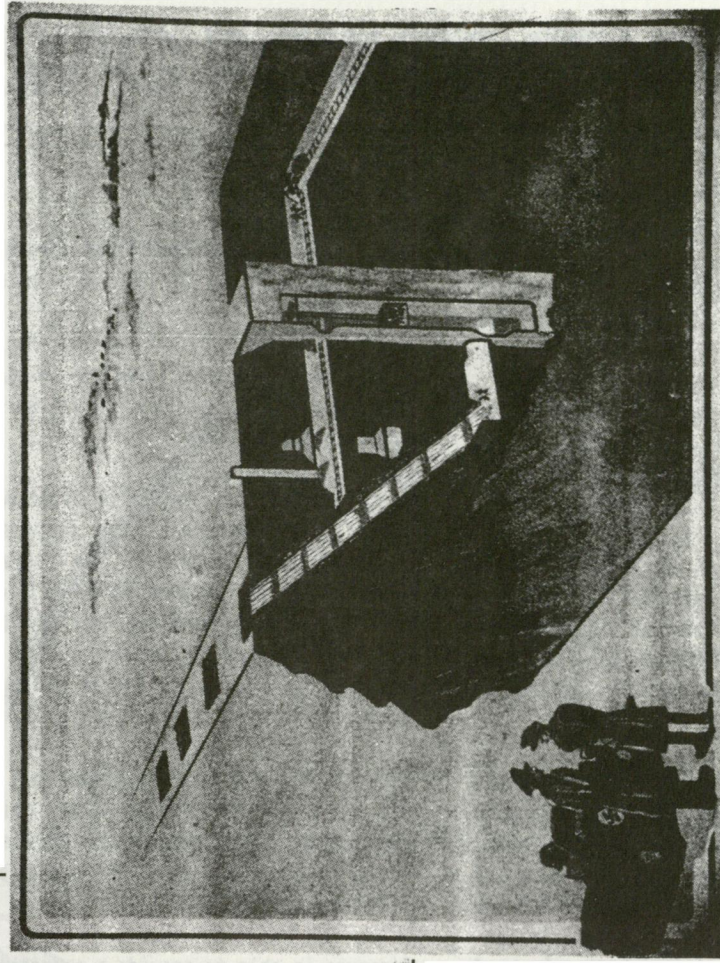
Between Calais and Boulogne, is one of the most outstanding and potentially devastating exploits of the 1939-1945 war,

Immense tunnels were excavated into the chalk of a grass covered hillside to shelter Hitler's secret project - the V3 (vengeance weapon No. 3) known to the French people as the London Cannon.

These underground installations are situated in the parish of Landrethun-le-Nord on the Departmental road no. 249, opposite the farm of Monsieur and Madame Vasseur, and it is now possible to visit a part of these tunnels.

The immensity and advanced state of these constructions, which were excavated entirely by hand, by persons of many nationalities who had been sentenced to political deportation as enemies of the Nazi Regime, leave a startling impression of the danger which threatened London and England.

The London Cannon



Guided tours are an hour in length,
Open Easter to November 2-6pm
July-August 10am-6pm

(The French are obviously expecting British people to cross over more frequently once the Channel Tunnel is complete, for they are already advertising tourist sites, such as the above, at the Channel Tunnel exhibitions in the district - Editor)

DINORWIG - the underground GIANT - NORTH WALES.

In a few short years, a remarkable feat was accomplished in a mountain near Llanberis in North Wales,

The heart of the mountain was tunnelled away and a pumped-storage power station - the largest in Europe - has been built in its place.

Dinorwig is owned by the National Grid Division of the Central Electricity Generating Board, and its power is reaching homes and factories throughout England and Wales through the electricity network.

The station provides a large reserve of electricity to meet sudden demands. When called upon to operate it generates electricity by using water from a mountain reservoir to power its turbine-generators. The water is collected and pumped back at night, using off-peak electricity, so that it is used again and again.

Costing £400 million to build, Dinorwig is expected to pay for itself within eight years. It can supply enough electricity for several large cities for up to five hours, and in an emergency it can provide 1320 megawatts of electricity within just 10 seconds, yet passers-by see little evidence of the station. Most of it is buried in man-made caverns deep inside Elidir mountain at the foot of Llanberis Pass. Underground cables carry the power to Pentir, 9.7 kilometres (six miles) away, where it joins the national grid system.

THE SCHEME IN DETAIL

Marchlyn Mawr, an existing lake, has been enlarged to provide Dinorwig's upper reservoir. Llyn Peris, a lake about 500 metres (1,640 feet) below, has also been enlarged to provide the lower reservoir.

Dinorwig uses more than 6.6 million cubic metres (1,462 million gallons) of water during a full generating cycle. The water is retained in Marchlyn Mawr by a 600 metre-long rock filled dam, landscaped on the downward face to blend with the scenery. The upstream side is faced with asphalt to provide the necessary water seal and the flexibility to meet the pressure changes caused by such a vast weight of water being continually moved in and out of the lake.

The dam contains about 1.85 million cubic metres of rock fill and is about 35 metres higher than Marchlyn's former water level. The water level in the reservoir rises and falls 33 metres at maximum output.

THE UNDERGROUND WORKS

Water from Marchlyn Mawr flows through the hydraulic tunnels at a maximum rate of 390 cubic metres (85,000 gallons) a second

Inlet tunnels three kilometres long, including a vertical shaft 440 metres deep and 10 metres in diameter, carry the water to the turbines.

About three million tonnes of slate were excavated to create the station's network of huge tunnels and caverns. The main civil engineering contract was believed to be the largest ever let in the UK when it was placed in 1975. The underground chamber housing the main plant is one of the largest excavated caverns engineered in the world - twice as long and half as wide as a soccer pitch and higher than a 16 storey building.

Each of Dinorwig's six machines has a maximum capacity of 313 MW when the falling water drives them as turbine-generators. Each consumes 281 MW when they operate in the opposite direction as motor pumps powered by electricity from the national grid.

Dinorwig is able to provide a constant output of 1,680 MW to the national grid for five hours.

Its machines take six hours to pump the water back again to the upper reservoir.

For the initial operating period two of the six units will be kept spinning in air at no load to provide immediate reserve for the network. Normally these two machines will not be called upon to generate for more than two 15 minute periods on any day. They will be returned to the reserve role as soon as gas turbines at other stations had been run up and loaded to take over.

The remaining four units are assigned to system frequency regulation. Frequency control, like the reserve role, demands a fast response. But it also has a special requirement in that the machines can each be loaded and unloaded up to 40 times in a day.

Electricity generated at 18,000 volts in the machine hall is conducted by aluminium bus bars to the transformer hall where generator transformers step up the voltage to 400,000 volts.

Two sets of underground cables carry the power from the station 9.7 kilometres to Pentir and the 400kV grid line which feeds it into the national grid.

DINORWIG POWER STATION

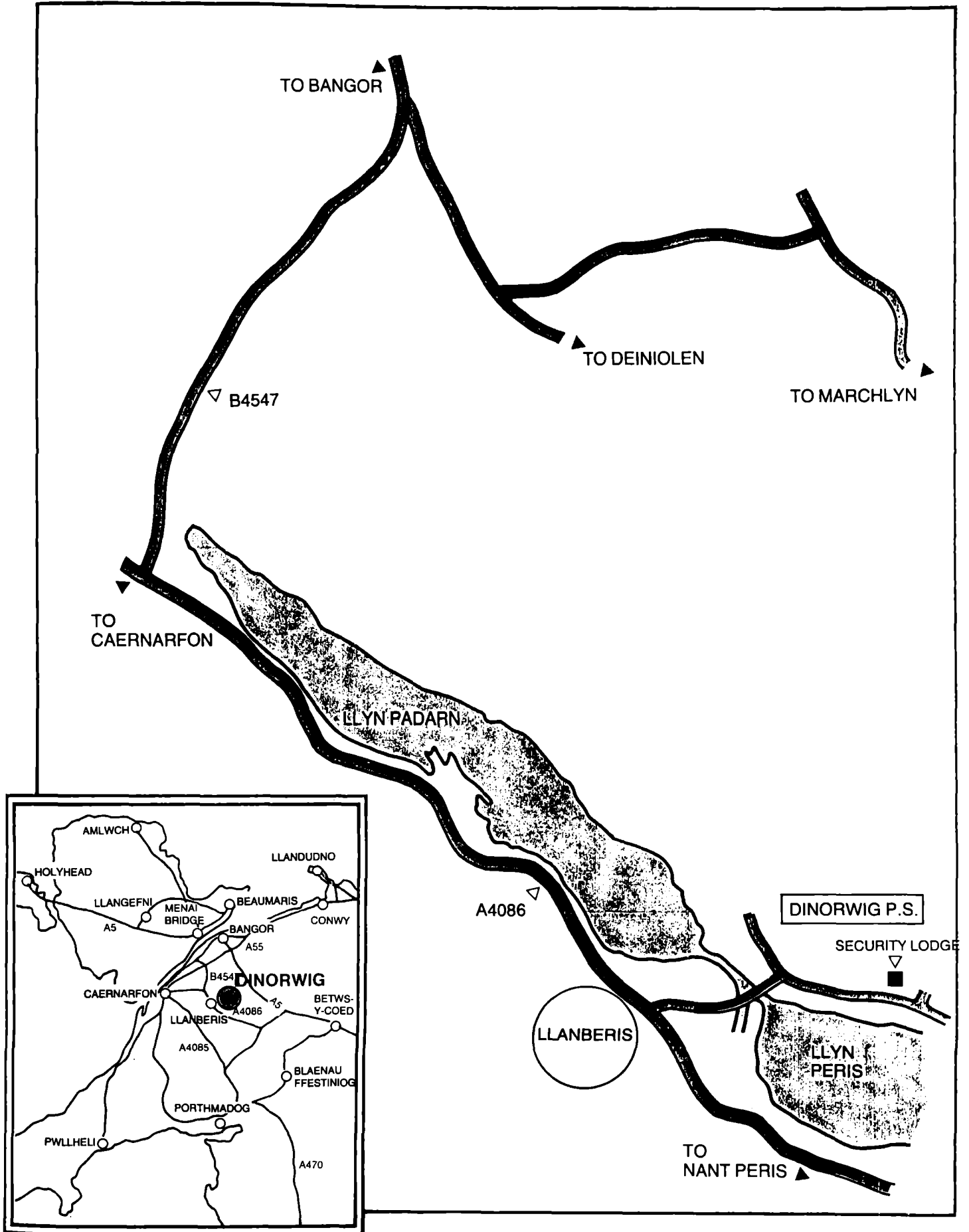
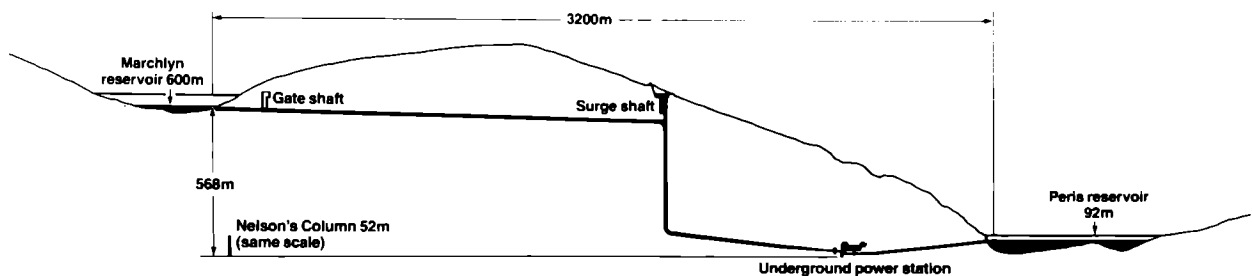
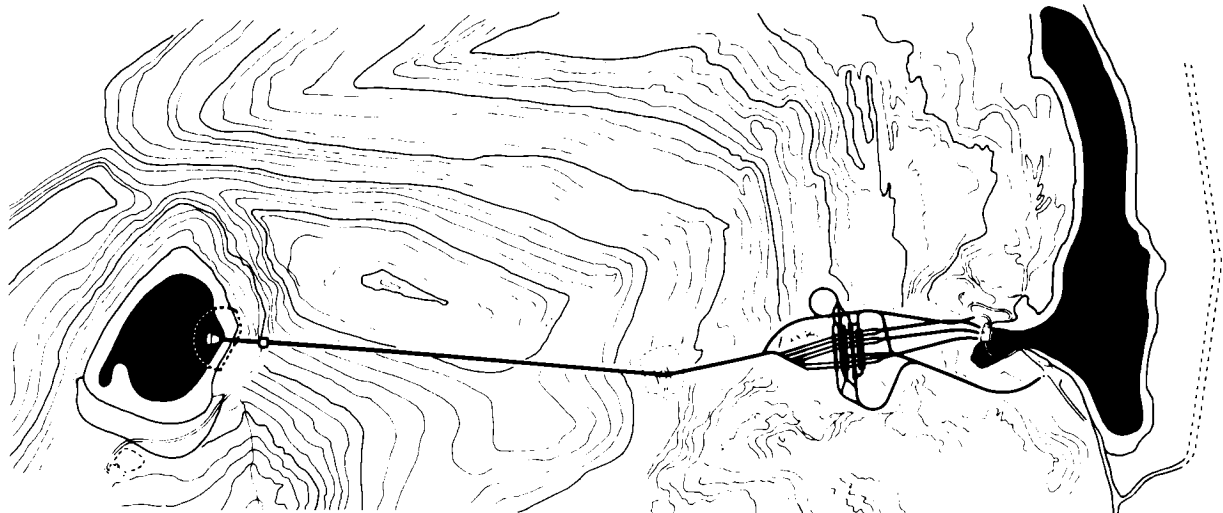




Plate 1

PLAN AND SECTION OF TUNNELS



LLYN PERIS

After passing through the turbines, the water flows out through three tailrace tunnels which discharge below the surface of Wellington Pool, a flooded part of the slate quarry which has been connected to Llyn Peris by removing rock between them.

Four million cubic metres of slate and rock waste tips have been removed to enlarge Llyn Peris from 37 hectares to 57 hectares to provide the necessary water volume. Llyn Peris is now restored to nearer its original size - slate waste tipped during the life of the quarries reduced the lake's area by about a third. The waste has been tipped into nearby quarry holes and on the lake bed below the lowest operating level.

The CEBB modified its original proposals after negotiations with the county council by reducing the height of the two landscaped embankments deepening Llyn Peris. The embankments are only 3.64 metres high.

The water level in Llyn Peris rises and falls by 14 metres when the station is operating at maximum capacity. Slate has been used to cover the lake edge between the high and low water levels, making the tide marks less noticeable.

WHY IS DINORWIG NEEDED?

Electricity cannot be stored in large quantities but the CEBB must have a large, quickly available reserve of power to meet sudden increases in demand on the national grid electricity supply system and to safeguard the nation's supplies in the event of a major failure of generating or transmission plant.

In England and Wales this "immediate reserve" is normally provided by operating coal and oil-fired power stations at below their full economic capacity so that their output can be increased quickly to meet additional demand when

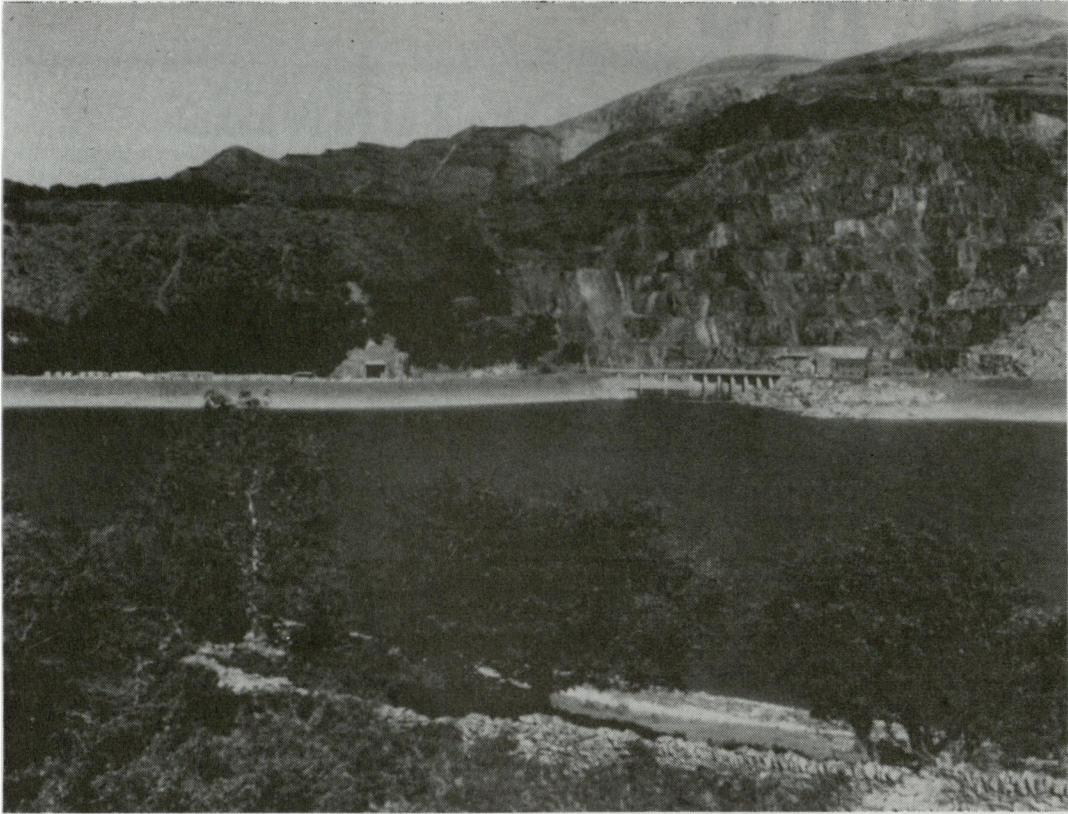


Plate 2

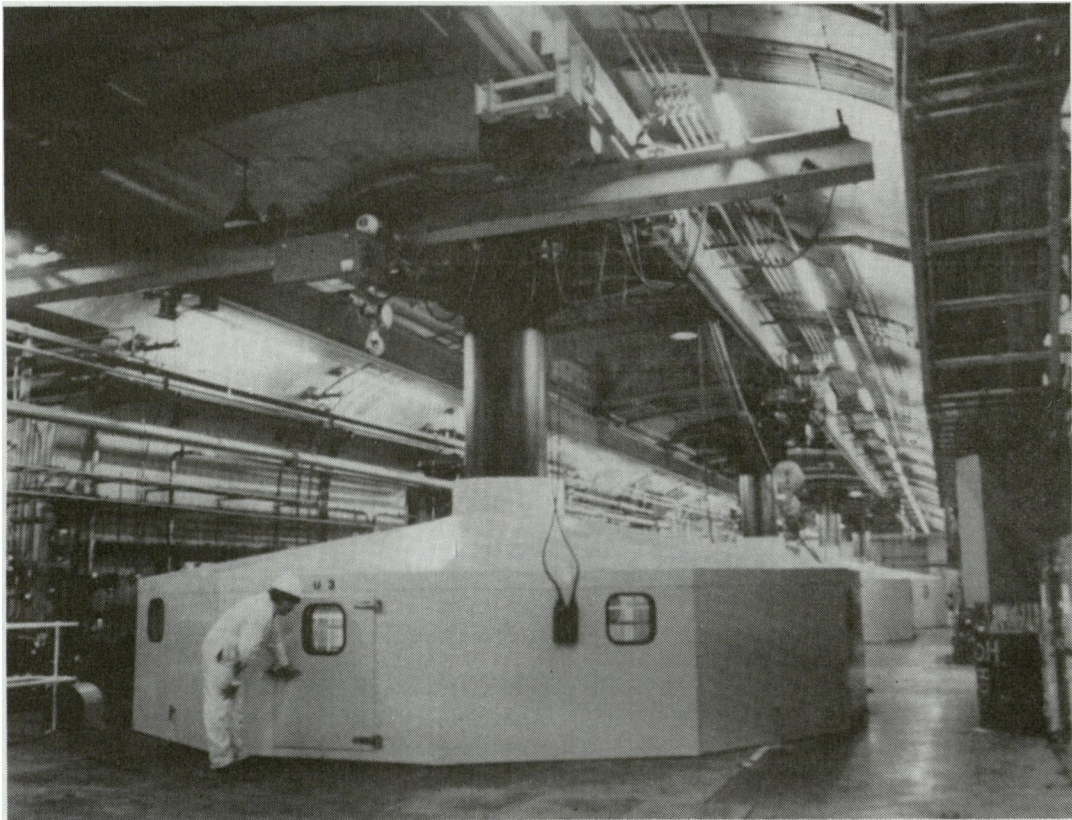


Plate 3



Plate 4

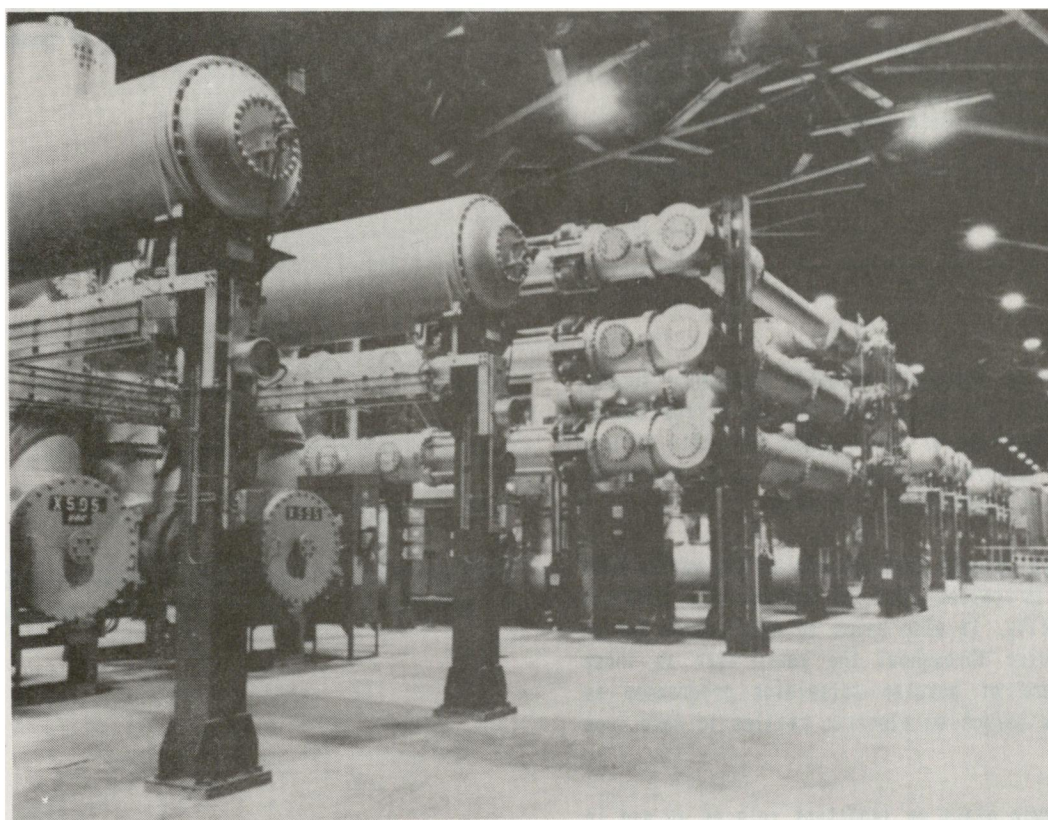
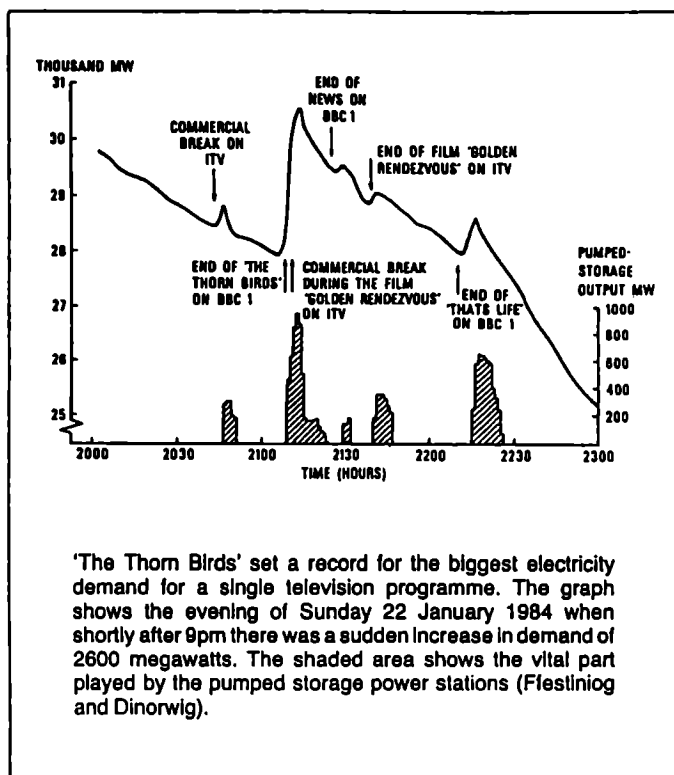


Plate 5

required. They are supported by gas turbine stations operating for short periods while output from bigger steam stations is increased.

Pumped-storage schemes, in effect, use water to store electrical energy. Electricity is used to pump water to the high reservoir. This is done mainly at night when demand for electricity is low and electricity for pumping is, therefore, cheaper, being provided by the most efficient power stations.

Hydro-electric and pumped-storage stations can be brought into operation much more quickly and reliably than other types of stations.



Dinorwig provides an immensely valuable emergency supply. For instance, should the Board lose the power from two of its 660 MW turbo-generators, the biggest currently in use, at the same time, Dinorwig can be brought in to reach the equivalent output of 1,320 MW in 10 seconds.

Dinorwig also helps to meet peak demands in the winter when the grid system is called upon to produce the greatest amount of electricity. It also helps to meet sudden surges in demand that occur throughout the year, such as those created at the end of popular television programmes as millions of people switch on electric kettles to make cups of tea or coffee.

In addition, Dinorwig plays an important role as an aid in maintaining the frequency of the grid supply so that electric clocks always show the correct time and other electrically-controlled equipment is not disturbed.

As well as delivering power, it also acts as a power sponge, soaking up surplus electricity during short spells of low demand by using it to pump water to its upper reservoir. This allows conventional thermal power stations to continue operating at their most efficient output rather than being run at uneconomic part-output for short periods or shut down.

IS IT ECONOMICAL?

Pumped-storage power stations use cheap electricity for pumping during off-peak periods and generate at times of peak demand at lower cost than the old and less efficient power stations that would otherwise have to be brought into operation. Consequently they save large sums of money, even though they produce only three units of electricity for every four they use in pumping.

Electricity for pumping is supplied overnight by the Board's most efficient power stations.

Hydro-electric stations, whose water sources are replenished by rain or snowfall, are obviously cheaper to operate but, unfortunately, all the viable hydro-electric sites in the UK have been developed and are of limited capacity. Pumped-storage schemes remain the only practical means of generating electricity from water power.

Nevertheless, Dinorwig provides a faster, more reliable and cheaper "immediate reserve" of electricity than that provided by steam stations. It gives the national grid, the world's largest inter-connected electricity supply system, greater flexibility at a price that could be approached in no other way so saving many millions of pounds during each year of its operational life.

Plate 1 - Aerial view of Dinorwig (photo 1989)

Plate 2 - General view of Dinorwig (photo 1986)

Plate 3 - Turbine Hall, Dinorwig (photo 1985)

Plate 4 - Control Room, Dinorwig (photo 1987)

Plate 5 - Sub-station Switch gear (photo 1987)

With thanks to The National Grid, Division of CEGB for permission to use their photographs and plans.

